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World Food and Agriculture

Some Problems and Issues

Sisay Asefa
Editor

1988

W. E. UPJOHN INSTITUTE for Employment Research
300 South Westnedge Avenue
Kalamazoo, Michigan 49007

Library of Congress Cataloging-in-Publication Data

World food and agriculture : economic problems and issues : papers presented in a seminar series / conducted by the Department of Economics at Western Michigan University : Sisay Asefa, editor.
p. cm.
"Presented during the 22nd Annual Economics Lecture Series at Western Michigan University"—Acknowledgments.
Contents: Introduction / Sisay Asefa — Ending African hunger / Carl K. Eicher — Foreign assistance and agriculture development : implications of the past 25 years for policy conditionality, capacity building, and sustainability / Uma Lele — Technical change and agricultural development / Vernon Ruttan — The political economy of agricultural and rural development / Bruce F. Johnston — Foreign assistance and American agriculture / C. Peter Timmer — United States agriculture in the global context / John W. Mellor.
ISBN 0-88099-067-8. ISBN 0-88099-066-X (pbk.)
1. Food supply—Congresses. 2. Agricultural assistance—Congresses. 3. Agricultural innovations—Congresses. I. Sisay Asefa, 1950- . II. Western Michigan University. Dept. of Economics. III. Title: Economics lecture series at Western Michigan University.
HD9000.5.W566 1988
338.1'9—dc19 88-29044
CIP

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ACKNOWLEDGEMENTS

The papers in this volume were presented during the 22nd Annual Economics Lecture Series at Western Michigan University. The series was made possible through the financial support of the W. E. Upjohn Institute for Employment Research and the College of Arts and Sciences of Western Michigan University. I am grateful to my colleagues in the Department of Economics, who assisted and cooperated during the progress of the series. The editorial suggestions and services of Judith Gentry and the staff of the W. E. Upjohn Institute for Employment Research are highly appreciated.

I am, of course, most grateful to the authors of the papers, without whose cooperation the publication of this volume would not have been possible.

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Introduction

Sisay Asefa
Western Michigan University

The Department of Economics of Western Michigan University was fortunate to attract six eminent agricultural economists to its 1986-87 lecture-seminar series to address various dimensions of the problem of world food and agriculture. This book contains six essays based on the public lectures delivered by the guest scholars during the 1986-87 academic year.

This introductory chapter will address and synthesize some of the main issues and problems of world food and agriculture and leave the reader to pursue the detailed discussion and analysis of the issues by the individual authors. The essays are presented in the order of the scholar's appearance in the lecture-seminar series.

Some of the main issues and problems addressed in the essays are: (1) the role of technical change in agricultural development; (2) the value of learning from historical and comparative experience in tackling rural and agricultural development problems; (3) the role of foreign assistance in agricultural and rural development; and (4) the current problem of hunger in Africa.

The Role of Technical Change in Agricultural Development

The issue of technical change in agricultural development is most extensively explored in Vernon Ruttan's essay. In his model of "induced technical change," Ruttan stresses the idea that technical change is indigenous, that is, made possible by farmers' responses to differences in availability and relative prices of resources.

He argues that differences in the economic environment and resource endowment are critical in influencing the direction of technical change. He supports his argument by presenting empirical evidence based on historical data on the experience of Japan and the United States in agricultural development. He points out that Japan adopted a biological and chemical agricultural technology that is land-substituting and labor-augmenting primarily as a response to the relative scarcity of arable land it faced during its historic agricultural development. On the other hand, the United States adopted a mechanical agricultural technology that is labor-substituting and land-using because it had relatively abundant arable land and scarce labour during its historic period of agricultural development. Ruttan shows, using comparative data of the two countries, that the difference in long-term trends in relative factor prices ''induced'' the different paths of technological change adopted by each country.

Bruce Johnston extends the issue of technical change beyond the critical role of relative factor prices and resource endowments by pointing out that the promotion of technical change in agriculture is not automatic and self-generating. He argues that the promotion of technical change requires active participation by both private and public institutions. The private aspect of technical change is determined by what he calls ''farm-level factors'' that require investments in land improvement, equipment, fertilizer, improved crop and livestock varieties, working capital, and skills of farmers. Individual farmers are in the best position to undertake the decision about the proper acquisition and utilization of these factors, while government can play a supportive role. On the other hand, inappropriate government policies, such as unfavourable price policy to farmers, can impede the development of these farm-level factors.

Successful adoption of farm-level technologies also requires what Johnston calls ''socially determined facts'' such as agricultural research, an extension system, and infrastructure, as well as appropriate macroeconomic policy environment. The latter factors, which are complementary to the farm-level factors, are beyond the control of individual farmers. They can best be provided by government.

The resource endowment situation of most developing countries is characterized by abundant rural labor that calls for effective utilization in the agricultural sector which in turn requires the adoption of labour-intensive chemical and biological technology as the most appropriate form of technical change. Chemical and biological technology that is yield-increasing is characterized by complementarity between inputs such as fertilizer and water. This implies that in a tropical and semi-arid environment, successful adoption of such technology requires adequate water availability that can only be provided by irrigation in the absence of reliable rainfall and the presence of recurrent drought.

Moreover, environmentally-specific chemical and biological technologies are not on the shelf for some tropical regions of the world such as Sub-Saharan Africa. It is therefore important to take up the challenge as stated by Ruttan: "Over the next few decades to develop agricultural research capacity in each agro-climate region of the world in order to take advantage of development in biological/chemical technology."

The critical obstacle to generation and adoption of agricultural technology in the future may not be the lack of scientific and technical change, but may arise from domestic economic policy and political barriers to technical progress in the agriculture of many developing countries.

The Value of Learning from Historical and Comparative Experience in Tackling Rural and Agricultural Development Problems

Lessons from historical experience of other countries are quite valuable in tackling problems of rural and agricultural development, provided they are correctly understood and applied. The significance of past experience in understanding the poverty problem in general is stated by T.W. Schultz in his inaugural lecture for winning the Nobel prize in development economics as follows: "Understanding the experience of poor people over the ages can contribute much to understanding the problems and possibilities of low-income countries today. That kind of understanding is far more important than the most detailed and exact knowledge about the surface of the earth, or of ecology, or of tomorrow's technology."[1]

The historical experience of Japan and the United States in choosing the technological path appropriate to their relative resource endowment has already been pointed out. Further, as argued in Johnston's essay, the Japanese experience is perhaps the most relevant for today's developing countries, since it involved increasing small farm productivity by adopting labor-intensive biological/chemical technology in the form of fertilizer and improved crop varieties as well as the concurrent development of agriculture and industry which allowed positive interaction between the two sectors and gradual absorption of labour by industry and other sectors of the economy. If agricultural productivity had not risen to provide adequate food supplies, the terms of trade would have turned against the industrial sector retarding the growth of the Japanese economy. However, this was prevented by Japan's successful adoption of biological and chemical technology which increased food production as well as provided necessary employment during the historic transformation of the economy.

Comparative lesssons from a more recent experience of other developing countries, such as India and China, also have some useful implications for regions of the currently deficient agriculture and food production, such as Sub-Saharan Africa. The Indian case is presented by Uma Lele who reminds us that, after the earlier policies that undervalued agriculture and contributed to the food crisis of the 1960s, India later carried out an economic reform which included the development of a strong agricultural research system and an effective fertilizer distribution network, raised farm commodity prices, and provided incentives to farmers to use fertilizer and new crop varieties. Lele points out further tht the food situation of India before and during the reform 20 years ago was similar to the current food and agricultural situation in Ethiopia and Sub-Saharan Africa.

While the institutional context is different, China's simultaneous emphasis on rural and agricultural development and rural industrialization featured by small labor-intensive rural industries also provides a valuable lesson. Furthermore, China's experience with the organization of agriculture demonstrates a valuable lesson about the limitation of collectivized agriculture as a viable economic unit of agricultural development. After a long experience with collective farming, China found that even small collective farms posed serious incentive and managerial problems and introduced, since 1981, reforms that have essentially returned Chinese agriculture to a system of individual household farming units.

Valuable lessons from comparative experience can be drawn not only from similarities but from dissimilarities, as stated by Lele. She points out that, while Africa and India are of about the same geographical size, Africa is much more diverse, constituting some 50 different nations, about one thousand ethnic groups, and several thousand languages. India, on the other hand, is one country with less diversity than Africa. More significantly, Lele states that India's food production problem was simplified by the fact that it was primarily a problem of increasing the production of wheat and rice, for which technology was being developed by the international research centres in cooperation with Indian agricultural scientists. The current food production problem in Africa, on the other hand, is more complex than the Indian case, since it means the development and adoption of technologies for a more complex and diverse food grain system, such as sorghum, millet, maize, cassava, root crops, for most of which environmentally-specific and locally tested technologies have not been developed.

The Role of Foreign Assistance in Agricultural and Rural Development

Foreign assistance can play an important role in agricultural and rural development provided that it is properly focused and utilized in alleviating rural poverty. Considerable experience with foreign assistance has been gained over the past few decades to help distinguish between which types of assistance have been successful and unsuccessful. Foreign assistance has the greatest potential to succeed when it is focused on agricultural and rural development. As John Mellor notes, this is because of the employment- and income-generating implication of agriculture that make increased food production and increased employment "two sides of the same coin." Increased food production can initiate multiple forces of growth, employment and income generation in the whole economy of a typical developing country characterized by the majority of its population still on the rural sector, as implied in Mellor's essay.

Peter Timmer and John Mellor are in general agreement on the notion that improving agricultural and food production in developing countries has a positive sum outcome of reducing poverty in the Third World and increasing U.S. farm exports. Timmer's analysis, which emphasizes a macroeconomic framework, is, however, cautiously optimistic about the implication of increased food production in the Third World for U.S. agricultural exports. He shows, through a complex web of general equilibrium relationships, the structural adjustment to global competitive pressures required by U.S. agriculture in the future.

Another feature of successful foreign assistance is that it is long term and sustained, as noted by Eicher and Lele. Currently, there are good reasons to be concerned with the state of foreign assistance in Africa, which appears to be short term, unstable, and uncoordinated. Numerous donors guided with diverse objectives and criteria are engaged in the "business of foreign assistance" in Africa. The value of some of this assistance in reducing poverty and hunger is quite questionable. Eicher raises a challenging question to donors when he asks: "Why did the U.S. government take the long view in India in the 1960s when it helped develop 23 new state agricultural universities and funded their development for 15 years? Why is the United States taking the short-run view in Africa in the 1980s?"

As a form of development assistance, food aid, which is currently popular, is quite inadequate. It can only be justified as a tool of famine relief, as stated by Johnston. Food assistance can even be harmful because it may divert the attention of governments from the critical problem of long-run agricultural development and poverty alleviation required for ending hunger. Moreover, it cannot be sustained in the long run and has the potential of being used as a political tool by donors and recipients.

The Current Problem of Hunger in Africa

The contemporary problem of hunger in Africa is most directly addressed in Carl Eicher's essay, where he outlines six challenges that must be faced by scientists, policymakers and politicians in order to end hunger in Africa. I find three of these challenges especially crucial. One challenge posed by Eicher to African politicians and governments is to look back and learn from their own experience of recent history and correct the mistaken economic policies that undervalued agriculture and food production, and to face up to the fundamental fact that agricultural development is an evolutionary and complex process that does not lend itself to rhetoric, ideology, or crash food production campaigns. Current and future generations of African policymakers must learn from the painful experience of some African nations that wasted a generation on revolutionary rhetoric and ideological entanglement in global power politics, and on hasty, ill-planned rural and agricultural experimentation that has contributed to increasing mass poverty and hunger.

Another challenge is the need to make a critical investment in human capital development and carry out necessary educational reforms away from the colonial elitist model that sets wrong curriculum priorities and undermines technical and agricultural education. For instance, the University of Botswana, 22 years after independence, does not have a faculty of engineering or technology, and its faculty of agriculture is just being launched during the current academic year.

The final challenge posed by Eicher is the need for policymakers, both donors and recipients, to focus in what he calls "the prime movers" of agricultural development, such as new technology generation and adoption, human capital and managerial skill development, biological and physical capital development, institutional development and implementation, as well as development of an economic policy environment favorable to agriculture and food production. It is important, as pointed out by Eicher, for donors and African governments to make long-term and sustained investments simultaneously on all of these "prime movers" due to their complementary and lengthy gestation period. Emphasis on one factor, such as the one currently prescribed by the International Monetary Fund (IMF) and the World Bank for making domestic price policy reform in exchange for additional loans and grants can be ineffective. In other words, policy initiatives such as domestic currency devaluation, abolishing price controls, eliminating government grain boards and fertilizer subsidies, when carried out is isolation without any clear guidelines and assistance to manage the political and economic consequences, will be unlikely to succeed, as Eicher's essay implies.

In sum, African governments and policymakers must take the primary responsibility and effort in restructuring their domestic policy environment. Donors can assist in complementing this effort by making a necessary long term and sustained investment in agricultural and rural development.

NOTE

1. See the Nobel Lecture by T.W. Schultz "The Economics of Being Poor," *Journal of Political Economy, 1980,* 88, 4, p. 641.

Technical Change and Agricultural Development

Vernon W. Ruttan
University of Minnesota

We are, in the closing years of the twentieth century, completing one of the most remarkable transitions in the history of agriculture. Prior to this century, almost all increase in food production was obtained by bringing new land into production. There were only a few exceptions to this generalization—in limited areas of East Asia, in the Middle East, and in Western Europe. By the end of this century, almost all of the increase in world food production must come from higher yields—from increased output per hectare. In most of the world, the transition from a resource-based to a science-based system of agriculture is occurring within a single century. In a few countries this transition began in the nineteenth century. In most of the presently developed countries it did not begin until the first half of this century. Most of the countries of the developing world have been caught up in the transition only since mid-century.

Models of Technical Change in Agriculture

The traditional literature on agricultural development can be classified under five general headings. These are (1) the resource exploitation, (2) the conservation, (3) the location, (4) the diffusion, and (5) the high-payoff input models.

The Resource Exploitation Model

Throughout most of history, expansion of the area cultivated or grazed has represented the dominant source of increase in agricultural production. The most dramatic example in western history was the opening up of the new continents—North and South America and Australia—to European settlement during the eighteenth and nineteenth centuries. With the advent of cheap transport during the latter half of the nineteenth century, the countries of the new continents became increasingly important sources of food and agricultural raw materials for the metropolitan countries of Western Europe.

Similar processes had occurred earlier, though at a less dramatic pace, in the peasant and village economies of Europe, Asia, and Africa. The agrarian colonization of the Indus and Ganges river valleys occurred in the third millennium B.C. The first millennium A.D. saw the agricultural colonization of Europe north of the Alps, the Chinese settlement of the lands south of the Yangtze, and the Bantu occupation of Africa south of the tropical forest belts. Intensification of land use in existing villages was followed by pioneer settlement, the establishment of new villages, and the opening up of forest or jungle land to cultivation. In Western Europe there was a series of successive changes from neolithic forest fallow to systems of shifting cultivation of bush and grassland followed first by short fallow systems, and later by annual cropping.

Where soil conditions were favorable, as in the great river basins and plains, the new villages gradually intensified their system of cultivation. Where soil resources were poor, as in many of the hill and upland regions, new areas were opened up to shifting cultivation or nomadic grazing. Under conditions of rapid population growth, the limits to the resource exploitation model were often quickly realized. Crop yields were typically low—measured in terms of output per unit of seed rather than per unit of crop area. Output per hectare and per man-hour tended to decline—except in the delta areas of Egypt and South Asia and in the wet rice areas of East Asia. In many areas the result was increasing burden on the peasantry.

Agriculture carried on within the framework of the resource exploitation model was, in most parts of the world, capable of supporting only very limited urban concentrations—trading centers and seats of government. Most food was consumed in the village in which it was produced. Much of the surplus that did become available was extracted from the village by the landlords in the form of rents, and by the church in the form of tithes. The limited surplus that could be accumulated exerted a decisive impact on political organizations. Charlemagne's campaigns against the Germans to extend his Frankish kingdom could not be waged until early summer. The great heavy horses that carried his armed knights had to be out on grass, after a winter on poor feed, long enough to get in condition.

There are relatively few remaining areas of the world where development along the lines of the resource exploitation model will represent an efficient source of growth during the last two decades of the twentieth century. The 1960s saw the "closing of the frontier" in most areas of Southeast Asia. In Latin American and Africa, the opening up of new lands awaits development of technologies for the control of pests and diseases (such as the tsetse fly in Africa) or for the release and maintenance of productivity of problem soils. The decline in food production that has been experienced in many African countries over the last several decades is an insistent reminder that agricultural growth along the lines described by the resource exploitation model is no longer a reliable source of growth in food production.

The Conservation Model

The conservation model of agricultural development evolved from the advances in crop and livestock husbandry associated with the English agricultural revolution and the notions of soil exhaustion suggested by the early German chemists and soil scientists. It was reinforced by the application to land of the concept, developed in the English classical school of economics, of diminishing returns to labor and capital.

Until well into the twentieth century, the conservation model of agricultural development was the only approach to intensification of agricultural production available to most of the world's farmers. Its application is effectively illustrated by the development of the wet rice culture systems that emerged in East and Southeast Asia and by the labor- and land-intensive systems of integrated crop-livestock husbandry which increasingly characterized European agriculture during the eighteenth and nineteenth centuries.

During the English agricultural revolution, more intensive crop rotation systems replaced the open-three-field system in which arable land was allocated between permanent cropland and permanent pasture. This involved the introduction and more intensive use of new forage and green manure crops and an increase in the availability and use of animal manures. This ''new husbandry'' permitted the intensification of crop-livestock production through the recycling of plant nutrients, in the form of animal manures, to maintain soil fertility. The inputs used in this conservation system of farming—the plant nutrients, animal power, land improvements, physical capital, and agricultural labor force—were largely produced or supplied by the agricultural sector itself.

Agricultural development, within the framework of the conservation model, clearly was capable in many parts of the world of sustaining rates of growth in agricultural production in the range of 1.0 percent per year over relatively long periods of time. The most serious recent effort to develop agriculture within this framework was made by the People's Republic of China in the late 1950s and early 1960s. It became readily apparent, however, that the feasible growth rates, even with a rigorous recycling effort, were not compatible with modern rates of growth in the demand for agricultural output—which typically fall in the 3-5 percent range in the less developed countries (LDCs). The conservation model remains an important source of productivity growth in most poor countries and an inspiration to agrarian fundamentalists and the organic farming movement in the developed countries.

The Location Model

Initially, the location model was formulated in Germany by J.H. von Thünen to explain geographic variations in the intensity of farming systems and the productivity of labor in an industralizing society. In the United States, it was extended to explain the more effective performance of the input and product markets in regions of rapid urban-industrial development than in regions of slower urban-industrial development. In the 1950s, interest in the location model reflected concern with the failure of agricultural resource development and price policies, adopted in the 1930s, to remove the persistent regional disparities in agricultural productivity and rural incomes in the United States.

The rationale for this model was developed in terms of more effective input and product markets in areas of rapid urban-industrial development. Industrial development stimulated agricultural development by expanding the demand for farm products, supplying the industrial inputs needed to improve agricultural productivity, and drawing away surplus labor from agriculture. The empirical tests of the location model have confirmed repeatedly that a strong nonfarm labor market is a prerequisite for labor productivity in agriculture and improved incomes for rural people.

The policy implications of the location model appear to be most relevant for less developed regions of highly industrialized countries or lagging regions of the more rapidly growing LDCs. Agricultural development policies based on this model appear to be particularly inappropriate in those countries where the ''pathological'' growth of urban centers is a result of population pressures in rural areas running ahead of employment growth in urban areas.

The Diffusion Model

The diffusion of better husbandry practices was a major source of productivity growth even in premodern societies. The diffusion of crops and animals from the new world to the old—potatoes, maize, cassava, rubber—and from the old world to the new—sugar, wheat, and domestic livestock—was an important by-product of the voyages of discovery and trade from the fifteenth to the nineteenth centuries.

Diffusion of crops and animals had historically proceeded as a by-product of trade, discovery and migration. The diffusion of maize to the Old World is an example. Within a decade after Columbus had first displayed Indian Corn (maize) at the Spanish court, it was being grown in the Po Valley in Northern Italy. In that relatively short time it had diffused from Spain and across North Africa to Turkey and was brought to the Po Valley by Venetian traders.

By the latter part of the nineteenth century, all major agricultural nations were actively engaged in organized crop exploration and introduction. The famous trip of Captain Bligh to the South Pacific, described in the book and the film, *Mutiny on the Bounty,* was undertaken as a crop exploration mission. His assignment was to bring back breadfruit seedlings and wild sugarcane cultivars.

Botanical gardens were established by the great colonial powers primarily to serve as crop introduction stations. The diffusion of rubber from Brazil to Southeast Asia illustrates their role. When the process of vulcanization was invented—making it possible to produce such desirable products as rubber boots, raincoats and tyres—the price of natural rubber, produced from wild trees in the Amazon basin of Brazil, skyrocketed. Brazil made it illegal to export either rubber seeds or rubber plants. The British sent a botanical expedition to Brazil with the ostensible purpose of collecting plants that had medicinal value, but they also brought back rubber seeds. The seeds were first sprouted at the Royal Botanical Garden at Kew. The seedlings were then transferred to the botanical gardens at Kandy (Ceylon) and in Singapore. The Kandy seedlings died but the Singapore seedlings lived and became the foundation stock of the rubber industry in Southeast Asia.

In the early post-World War II period, the diffusion model provided the intellectual foundation for technical assistance to developing countries. President Truman talked about American "know-how—show-how." The naive diffusion approach drew on the empirical observation of substantial differences in land and labor productivity among farmers and regions. The route to agricultural development in this view was through more effective dissemination of technical knowledge and the narrowing of productivity differences.

The diffusion model has provided the major intellectual foundation of much of the research and extension effort in farm management and production economics since the emergence, in the latter years of the nineteenth century, of agricultural economics and rural sociology as separate subdisciplines linking the agricultural and the social sciences. Developments leading to the establishment of active programs of farm management research and extension occurred at a time when experiment station research was making only a modest contribution to agricultural productivity growth. A further contribution to the effective diffusion of known technology was provided by rural sociologists' research on the diffusion process. Models were developed emphasizing the relationship between diffusion rates and the personality characteristics and educational accomplishments of farm operators.

Insights into the dynamics of the diffusion process, when coupled with the observation of wide agricultural productivity gaps among developed and less developed countries and a presumption of inefficient resource allocation among "irrational, tradition-bound" peasants, produced an extension or diffusion bias in the choice of agricultural development strategy in many LDCs during the 1950s. During the 1960s, the limitations of the diffusion on technology transfer model as a foundation for the design of agricultural development policies became increasingly apparent as technical assistance and rural development programs—based explicitly or implicitly on this model—failed to generate either rapid modernization of traditional farms and communities or rapid growth in agricultural output. There were very few opportunities to generate large productivity gains through the transfer of technology from one agroclimatic zone to another, or even among regions in the same agroclimatic zone. The pipeline was empty!

The High-Payoff Input Model

The inadequacy of policies based on the conservation, urban-industrial impact, and diffusion models led, in the 1960s, to a new perspective: The key to transforming a traditional agricultural sector into a productive source of economic growth is investment designed to make modern, high-payoff inputs available to farmers in poor countries. Peasants in traditional agricultural systems were viewed as rational, efficient resource allocators.

In *Transforming Traditional Agriculture,* T.W. Schultz insisted that peasants in traditional societies remained poor because there were only limited technical and economic opportunities to which they could respond. The new, high-payoff inputs were classified according to three categories: (1) the capacity of public and private sector research institutions to produce new technical knowledge; (2) the capacity of the industrial sector to develop, produce, and market new technical inputs; and (3) the capacity of farmers to acquire new knowledge and use new inputs effectively.

The enthusiasm with which the high-payoff input model has been accepted and translated into economic doctrine has been due in part to the proliferation of studies reporting high rates of return to public investment in agricultural research (table 1). It was also due to the success of efforts to develop new, high-productivity grain varieties suitable for the tropics. New, high-yield wheat varieties were developed in Mexico beginning in the 1950s, and new, high-yield rice varieties were developed in the Philippines in the 1960s. These varieties were highly responsive to industrial inputs such as fertilizer and other chemicals and to more effective soil and water management. The high returns associated with the adoption of the new varieties and the associated technical inputs and management practices have led to rapid growth in investment in agricultural research and to the development and adoption of the new and more productive crop varieties among farmers in a number of countries in Asia, Africa, and Latin America.

But the acceptance of the high-payoff input model has been incomplete. Many countries have not yet freed their private sector to produce and market the new technical inputs that enhance productivity. Those are functions which the public sector typically performs poorly. The constraints placed on market development continue to deprive farmers and consumers of the gains from new technology that are becoming available.

There has been even greater reluctance, in a number of developing countries, to accept the implication of the high-payoff input model for the schooling of farm people. The intellectuals and planners in many developing countries find it difficult to understand the importance, for agricultural development, of a literate and a numerate peasantry. When advances in agricultural technology occurred slowly, the apprenticeship mode of learning, without formal schooling, from family and village elders was adequate. But when a continuous stream of new biological and mechanical technology becomes available the returns to the acquisition of new skills in production and marketing are driven up. It becomes important not only to accept but also to be able to adapt or reject the new "packages" of practices and inputs being recommended by research and extension services. Agricultural extension services themselves must be able to advance beyond simply recommending a package of practices or delivering technological and managerial messages to farmers. They must advance from teaching practices to teaching principles!

It seems quite clear that Pakistan has not yet made the investment in the schooling of rural people to enable it to take full advantage of the potentially high-payoff technology that is becoming available. In spite of one of the world's great pieces of agricultural real estate—35 million acres of irrigated land in the Indus basin—yields remain low by Asian standards. It is hard to avoid a conclusion that underinvestment in human capital has dampened the rate of return to investment in land and water development and to agricultural research and extension.

Induced Technical Change in Agriculture

The high-payoff input model remains incomplete as a theory of agricultural development. Typically, education and research are public goods not traded through the marketplace. The mechanism by which resources are allocated among education, research, and other public and private sector economic activities was not fully incorporated into the model. It does not explain how economic conditions induce the development and adoption of an efficient set of technologies for a particular society. Nor does it attempt to specify the processes by which input and product price relationships induce investment in research in a direction consistent with a nation's particular resource endowments.

These limitations in the high-payoff input model led Yujiro Hayami and I to develop a model of agricultural development in which technical change is treated as an exogenous factor. This induced innovation

Table 1
Summary Studies of Agricultural Research Productivity

Study	Country	Commodity	Time period	Annual internal rate of return (%)
Index number:				
Griliches, 1958	USA	Hybrid corn	1940-1955	35-40
Griliches, 1958	USA	Hybrid sorghum	1940-1957	20
Peterson, 1967	USA	Poultry	1915-1960	21-25
Evenson, 1969	South Africa	Sugarcane	1945-1962	40
Barletta, 1970	Mexico	Wheat	1943-1963	90
Barletta, 1970	Mexico	Maize	1943-1963	35
Ayer, 1970	Brazil	Cotton	1924-1967	77+
Schmitz and Seckler, 1970	USA	Tomato harvester, with no compensation to displaced workers	1958-1969	37-46
		Tomato harvester, with compensation to displaced workers for 50% of earnings loss		16-28
Ayer and Schuh, 1972	Brazil	Cotton	1924-1967	77-110
Hines, 1972	Peru	Maize	1954-1967	35-40[a]
				50-55[b]
Hayami and Akino, 1977	Japan	Rice	1915-1950	25-27
Hayami and Akino, 1977	Japan	Rice	1930-1961	73-75
Hertford, Ardila, Rocha and Trujillo, 1977	Colombia	Rice	1957-1972	60-82
		Soybeans	1960-1971	79-96
		Wheat	1953-1973	11-12
		Cotton	1953-1972	none
Pee, 1977	Malaysia	Rubber	1932-1973	24
Peterson and Fitzharris, 1977	USA	Aggregate	1937-1942	50
			1947-1952	51
			1957-1962	49
			1957-1972	34

Wennergren and Whitaker, 1977	Bolivia	Sheep	1966-1975	44
		Wheat	1966-1975	-48
Pray, 1978	Punjab (British India)	Agricultural research and extension	1906-1956	34-44
	Punjab (Pakistan)	Agricultural research and extension	1948-1963	23-37
Scobie and Posada, 1978	Bolivia	Rice	1957-1964	79-96
Pray, 1980	Bangladesh	Wheat and rice	1961-1977	30-35
Regression analysis:				
Tang, 1963	Japan	Aggregate	1880-1938	35
Griliches, 1964	USA	Aggregate	1949-1959	35-40
Latimer, 1964	USA	Aggregate	1949-1959	not significant
Peterson	USA	Poultry	1915-1960	21
Evenson, 1968	USA	Aggregate	1949-1959	47
Evenson, 1969	South Africa	Sugarcane	1945-1958	40
Barletta, 1970	Mexico	Crops	1943-1963	45-93
Duncan, 1972	Australia	Pasture improvement	1948-1969	58-68
Evenson and Jha, 1973	India	Aggregate	1953-1971	40
Cline, 1975 (revised by Knudson & Tweeten, 1979)	USA	Aggregate	1939-1948	41-50^c
		Research and extension	1949-1958	39-47^c
			1959-1968	32-39^c
			1969-1972	28-35^c
Bredahl and Peterson, 1976	USA	Cash grains	1969	36^d
		Poultry	1969	37^d
		Dairy	1969	43^d
		Livestock	1969	47^d

Table 1 (continued)

Study	Country	Commodity	Time period	Annual internal rate of return (%)
Kahion, Bal, Saxena and Jha, 1977	India	Aggregate	1960-1961	63
Evenson and Flores, 1978	Asia-National	Rice	1950-1965	32-39
			1966-1975	73-78
	Asia-International	Rice	1966-1975	74-102
Flores, Evenson, and Hayami, 1978	Tropics	Rice	1966-1975	46-71
	Philippines	Rice	1966-1975	75
Nagy and Furtan, 1978	Canada	Rapeseed	1960-1975	95-110
Davis, 1979	USA	Aggregate	1949-1959	66-100
			1964-1974	37
Evenson, 1979	USA	Aggregate	1868-1926	65
	USA	Technology oriented	1927-1950	95
	USA	Science oriented	1927-1950	110
	USA	Science oriented	1948-1971	45
	Southern USA	Technology oriented	1948-1971	130
	Northern USA	Technology oriented	1948-1971	93
	Western USA	Technology oriented	1948-1971	95
	USA	Farm management research and agricultural extension	1948-1971	110

SOURCE: Robert E. Evenson, Paul E. Waggoner, and Vernon W. Ruttan, "Economic Benefits from Research: An Example from Agriculture," *Science*, 205 (September 14, 1979), pp. 1101-7. Copyright 1979 by the American Association for the Advancement of Science.

a. Returns to maize research only.

b. Returns to maize research plus cultivation "package."

c. Lower estimate for 13-, and higher for 16-year time lag between beginning and end of output impact.

d. Lagged marginal product of 1969 research on output discounted for an estimated mean lag of 5 years for cash grains, 6 years for poultry and dairy, and 7 years for livestock.

perspective was stimulated by historical evidence that different countries had followed alternative paths of technical change in the process of agricultural development. In the induced innovation model, changes or differences in the economic environment influence the direction of technical change.

In discussing the induced innovation Model, I will find it useful, at the risk of some oversimplification, to use the term *mechanical technology* to refer to those technologies which substitute for labor and the term *biological technology* to refer to those technologies which generate increases in output per hectare.

Mechanical and Biological Processes in Agricultural Production

The mechanization of agricultural production cannot be treated as simply an adaptation of industrial methods of production to agriculture. The spatial nature of agricultural production results in significant differences between agriculture and industry in patterns of machine use. It imposes severe limits on the efficiency of large scale production in agriculture.

The spatial dimension of crop production requires that the machines suitable for agricultural production must be mobile—they must move across or through materials that are immobile in contrast to moving material through stationary machines as in most industrial processes. Furthermore, the seasonal or spatial characteristics of agricultural production require a series of specialized machines—for land preparation, planting, weed control and harvesting—specifically designed for sequential operations, each of which is carried out for only a few days or weeks in each season. This means that it is no more feasible for workers to specialize in one operation in mechanized agriculture than in premechanized agriculture. It also means that in a "fully mechanized" agricultural system, the capital-labor ratio tends to be much higher than in the industrial sector in the same country.

In agriculture, biological and chemical processes are more fundamental than mechanization or machine processes. This generalization was equally true during the last century as it will be during the era of the "new biotechnology." Advances in biological and chemical technology in crop production have typically involved one or more of the following three elements: (a) land and water resource development to provide a more satisfactory environment for plant growth; (b) modification of the environment by the addition of organic and inorganic sources of plant nutrients to the soil to stimulate plant growth; (c) use of biological and chemical means to protect plants from pests and disease; and (d) selection and design of new biologically efficient crop varieties specifically adapted to respond to those elements in the environment that are subject to man's control. Similar processes can be observed in advances in animal agriculture.

The United States and Japan

One implication of the discussion of mechanical and biological processes is that there are multiple paths of technical change in agriculture available to a society. The constraints imposed by an inelastic supply of land may be offset by advances in biological technology. The constraints imposed by an inelastic supply of labor may be offset by advances in mechanical technology. These alternatives are illustrated in figure 1. The 1880-1980 land and labor productivity growth paths for Japan, Denmark, France, Germany, the United Kingdom and the United States are plotted, along with the 1980 productivity ratios for a number of developing countries. The impression given by the several growth paths is that nature is relatively "plastic."

In economics, it has generally been accepted, at least since the publication of *Theory of Wages* by Sir John Hicks, that changes or differences in the relative prices of factors of production could influence the direction of invention or innovation. There has also been a second tradition, based on the work of Griliches and Schmookler, that has focused attention on the influence of growth in product demand on the rate of technical change. We now turn to an illustration of the role of relative factor endowments and prices in the evolution of alternative paths of technical change in agriculture in the United States and Japan.

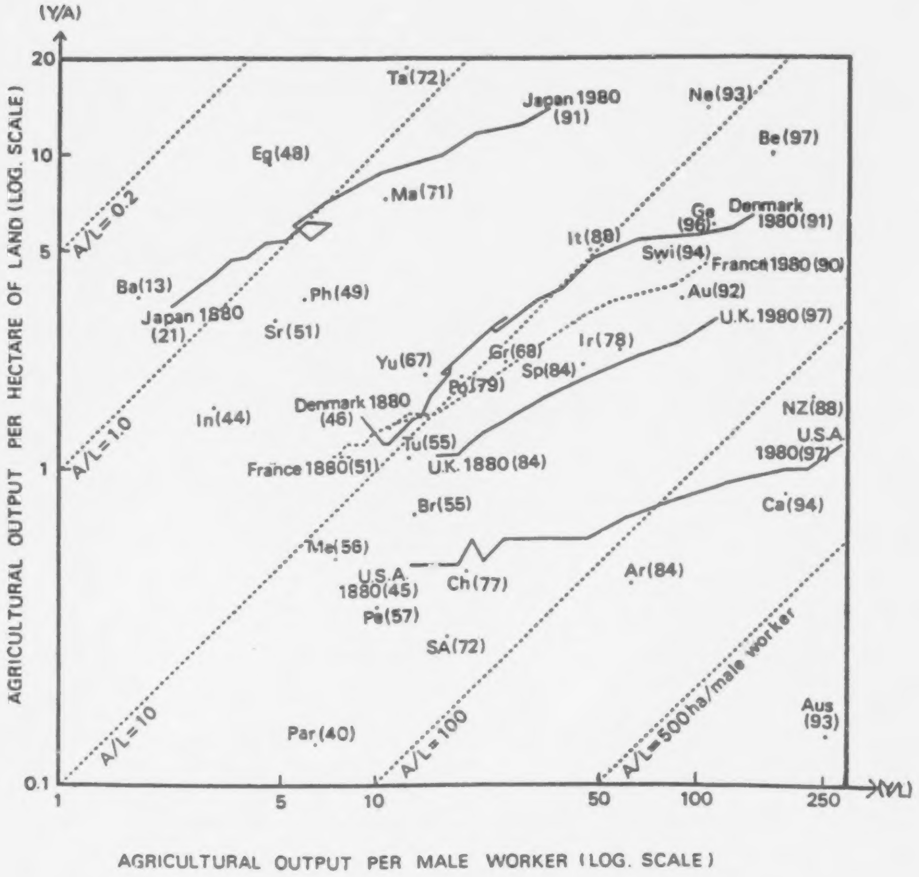

Figure 1 Historical growth paths of agricultural productivity of Denmark, France, Japan, the United Kingdom, and the United States for 1880-1980, compared with intercountry cross-section observations of selected countries in 1980. Values in parentheses are percent of male workers employed in nonagriculture. Data from Appendixes A and B, Hayami and Ruttan, *Agricultural Development*, rev. ed., 1985.

Japan and the United States are characterized by extreme differences in relative endowments of land and labor (table 2). In 1880, total agricultural land area per male worker was more than 60 times as large in the United States as in Japan, and arable land area per worker was about 20 times as large in the United States as in Japan. The differences have widened over time. By 1980, total agricultural land area per male worker was more than 100 times as large and arable land area per male worker about 50 times as large in the United States as in Japan.

The relative prices of land and labor also differed sharply in the two countries. In 1880 in order to buy a hectare of arable land (compare row 8 and row 16 in table 2), it would have been necessary for a Japanese hired farm worker to work eight times as many days as a U.S. farm worker. In the United States, the price of labor rose relative to the price of land, particularly between 1880 and 1920. In Japan, the price of land rose sharply relative to the price of labor, particularly between 1880 and 1900. By 1960 a Japanese farm worker would have had to work 30 times as many days as a U.S. farm worker in order to buy one hectare of arable land. This gap was reduced after 1960, partly due to extremely rapid increases in wage rates in Japan during the two decades of "miraculous" economic growth. In the United States, land prices rose sharply in the postwar period primarily because of the rising demand for land for nonagricultural use and the anticipation of continued inflation. Yet, in 1980 a Japanese farm worker still would have had to work 11 times as many days as a U.S. worker to buy one hectare of land.

In spite of these substantial differences in land area per worker and in the relative prices of land and labor, both the United States and Japan experienced relatively rapid rates of growth in production and productivity in agriculture (tables 3 and 4). Overall agricultural growth performance for the entire 100-year period was very similar in the two countries. In both countries, total agricultural output increased at an annual compound rate of 1.6 percent, while total inputs (aggregate of conventional inputs) increased at a rate of 0.7 percent. Total factor productivity (total output divided by total input) increased at an annual rate of 0.9 percent in both countries. Meanwhile, labor productivity measured by agricultural output per male worker increased at rates of 3.1 per-

Table 2
Land-Labor Endowments and Relative Prices in Agriculture
United States and Japan, Selected years

	1880	1900	1920	1940	1960	1980
USA						
(1) Agricultural land area (million ha.)	327	465	458	452	440	427
(2) Arable land area (million ha.)	93	157	194	189	185	191
(3) No. of male farm workers (thousand)	7,959	9,880	10,221	8,487	3,973	1,792
(4) (1)/(3) (ha./worker)	41	47	45	50	111	238
(5) (2)/(3) (ha./worker)	12	16	19	22	47	107
(6) Value of arable land ($/ha.)	109	106	341	178	696	3,393
(7) Farm wage rate ($/day)	0.90	1.00	3.30	1.60	6.60	25.31
(8) (6)/(7) (days/ha.)	188	106	103	111	105	134
Japan						
(9) Agricultural land area (thousand ha.)[a]	5,509	6,032	6,958	7,102	7,042	5,729
(10) Arable land area (thousand ha.)	4,749	5,200	5,998	6,122	6,071	5,461
(11) No. of male farm workers (thousand)	8,336	8,483	7,577	6,362	6,230	2,674
(12) (9)/(11) (ha./worker)	0.66	0.71	0.92	1.12	1.13	2.14
(13) (10)/(11) (ha./worker)	0.57	0.61	0.79	0.96	0.97	2.04
(14) Value of arable land (yen/ha.)	343	917	3,882	4,709	1,415,000	7,642,000
(15) Farm wage rate (yen/day)	0.22	0.31	1.39	1.90	440	5,054
(16) (14)/(15) (days/ha.)	1,559	2,958	2,793	2,478	3,216	1,512

SOURCE: Data from Appendix Tables C-2 and C-3 in Yujiro Hayami and Vernon W. Ruttan, *Agricultural Development: An International Perspective*, rev. ed. (Baltimore: Johns Hopkins University Press, 1985).

a. Agricultural land areas in Japan for 1880-1960 are estimated by multiplying arable land areas by 1.16, the ratio of agricultural land area to arable land area in the 1960 Census of Agriculture; this conversion factor changed to 1.05 for 1980 based on the 1980 Census of Agriculture.

Table 3
Average Annual Rates of Change (Percentage per Year) in Output, Inputs, and Productivity in U.S. Agriculture, 1870-1979

Item	1870-1900	1900-1925	1925-1950	1950-1965	1965-1982
Farm output	2.9	0.9	1.6	1.7	2.1
Total inputs	1.9	1.1	0.2	–0.4	0.2
Total productivity	1.0	–0.2	1.3	2.2	1.8
Labor inputs[a]	1.6	0.5	–1.7	–4.8	–3.4
Labor productivity	1.3	0.4	3.3	6.6	5.8
Land inputs[b]	3.1	0.8	0.1	–0.9	0.0
Land productivity	–0.2	0.0	1.4	2.6	1.8

SOURCES: Data from USDA, *Changes in Farm Production and Efficiency* (Washington, D.C. 1979); and D.D. Durost and G.T. Barton, *Changing Sources of Farm Output* (Washington, D.C.: USDA Production Research Report No. 36, February 1960). Data are three-year averages centered on the year shown for 1925, 1950 and 1965.

[a] Number of workers, 1870-1910; worker-hour basis, 1910-1971.

[b] Cropland use for crops, including crop failures and cultivated summer fallow.

Table 4
Average Annual Change in Total Output, Inputs, and Productivity in Japanese Agriculture, 1880-1980

Item	1880-1920	1920-1935	1935-1955	1955-1980	1965-1982
Farm output	1.8	0.9	0.6	3.5	1.2
Total inputs	0.5	0.5	1.2	1.3	0.7
Total productivity	1.3	0.4	–0.6	2.2	0.5
Labor inputs	–0.3	–0.2	0.6	-2.5	-3.7
Labor productivity	2.1	1.1	0.0	6.0	4.9
Land inputs	0.6	0.1	–0.1	0.1	–0.6
Land productivity	1.2	0.8	0.7	3.4	1.8

SOURCES: Data from Saburo Yamada and Yujiro Hayami, "Agricultural Growth in Japan, 1880-1970," in *Agricultural Growth in Japan, Taiwan, Korea and the Philippines*, Yujiro Hayami, Vernon W. Ruttan and Herman Southworth, eds. (Honolulu: University Press of Hawaii, 1979), pp. 33-58; Saburo Yamada, "The Secular Trends in Input-Output Relations of Agricultural Production in Japan, 1878-1978," a paper presented at the Conference of Agricultural Development in China, Japan, and Korea, Academica Sinica, Taipei, December 17-20, 1980; Saburo Yamada, *Country Study on Agricultural Productivity Measurement and Analysis - Japan* (Tokyo: University of Tokyo Institute of Oriental Culture, October 1984, mimeo).

cent per year in the United States and 2.7 percent in Japan. It is remarkable that the overall growth rates in output and productivity were so similar, despite the extremely different factor proportions that characterize the two countries.

Although there is a resemblance in the overall rates of growth in production and productivity, the time sequences of the relatively fast-growing phases and the relatively stagnant phases differ between the two countries. In the United States, agricultural output grew rapidly up to 1900; then the growth rate decelerated. From the 1900s to the 1930s there was little gain in total productivity. This stagnation phase was succeeded by a dramatic rise in production and productivity in the 1940s and 1950s. Japan experienced rapid increases in agricultural production and productivity from 1880 to the 1910s, then entered into a stagnation phase, which lasted until the mid-1930s. Another rapid expansion phase commenced during the period of recovery from the devastation of World War II. Roughly speaking, the United States experienced a stagnation phase two decades earlier than Japan and also shifted to the second development phase two decades earlier.

The effect of relative prices on the development and choice of technology is illustrated with remarkable clarity for biological technology in figure 2. In figure 2, U.S. and Japanese data on the relationship between fertilizer input per hectare of arable land and the fertilizer/land price ratio are plotted for the period 1880 to 1980. In both 1880 and 1980, U.S. farmers were using less fertilizer than Japanese farmers. Despite enormous differences in both physical and institutional resources, however, the relationship between these variables has been almost identical in the two countries. As the price of fertilizer declined relative to other factors, scientists in both countries responded by inventing crop varieties that were more responsive to the lower prices of fertilizer. American scientists, however, always lagged behind the Japanese by several decades because the lower prices of land relative to the price of fertilizer in the United States resulted in a lower priority being placed on yield-increasing technology.

The effect of changes in the relative prices of mechanical power and labor in the United States and Japan for 1880-1980 is illustrated in figure

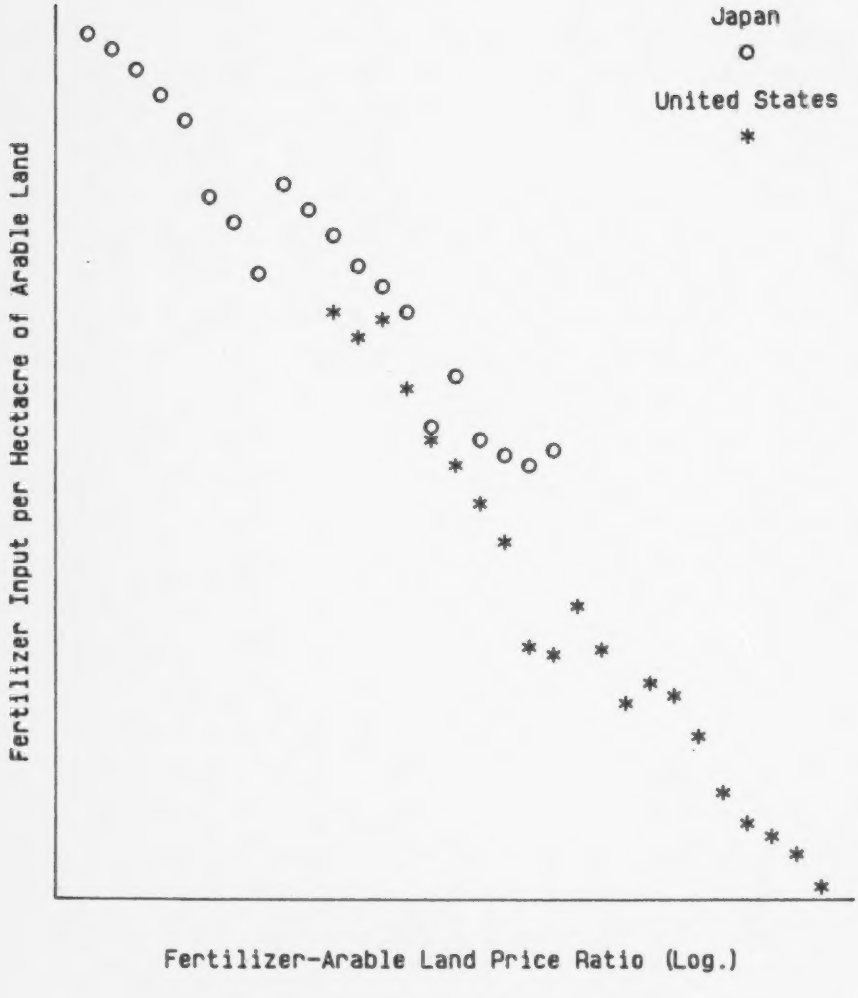

Figure 2 Relation between fertilizer input per hectare of arable land and fertilizer-arable land price ratio (=hectares of arable land which can be purchased by one ton of $N+P_2O_5+K_2O$ contained in commercial fertilizers), the United Sates and Japan, quinquennial observations for 1880-1980. Data from Appendix C, Hayami and Ruttan, *Agricultural Development*, rev. ed. (Baltimore: Johns Hopkins University Press, 1985).

3. In both 1880 and 1980, U.S. farmers were using more mechanical power than Japanese farmers. The relationship between the power-labor price ratio and the use of power per worker is almost identical in the two countries, but because labor was always less expensive in Japan, the Japanese suppliers of mechanical technology always lagged behind U.S. suppliers by several decades. These same relationships that hold for Japan and the United States have now been demonstrated for the period 1880-1960 for a number of European countries in the book by Hans P. Binswanger and Vernon W. Ruttan, *Induced Innovation: Technology, Institutions and Development.*

The effect of a rise in the price of fertilizer relative to the price of land or in the price of labor relative to the price of machinery has been to induce advances in biological and mechanical technology. The effect of the introduction of lower cost and more productive biological and mechanical technology has been to induce farmers to substitute fertilizer for land and mechanical power for labor. These responses to differences in resource endowments among countries and to changes in resource endowments over time by agricultural research institutions, by the farm supply industries, and by farmers, has been remarkably similar in spite of differences in cultures and traditions.

The results of our comparative analyses can be summarized as follows: Agricultural growth in the United States and Japan during the period 1880-1980 can best be understood when viewed as a dynamic factor substitution process. Factors have been substituted for each other along a metaproduction function in response to long-run trends in relative factor prices. Each point on the metaproduction surface is characterized by a technology which can be described in terms of specific sources of power, types of machinery, crop varieties, and animal breeds. Movements along this metaproduction surface involve technical changes. These technical changes have been induced to a significant extent by the long-term trends in relative factor prices.

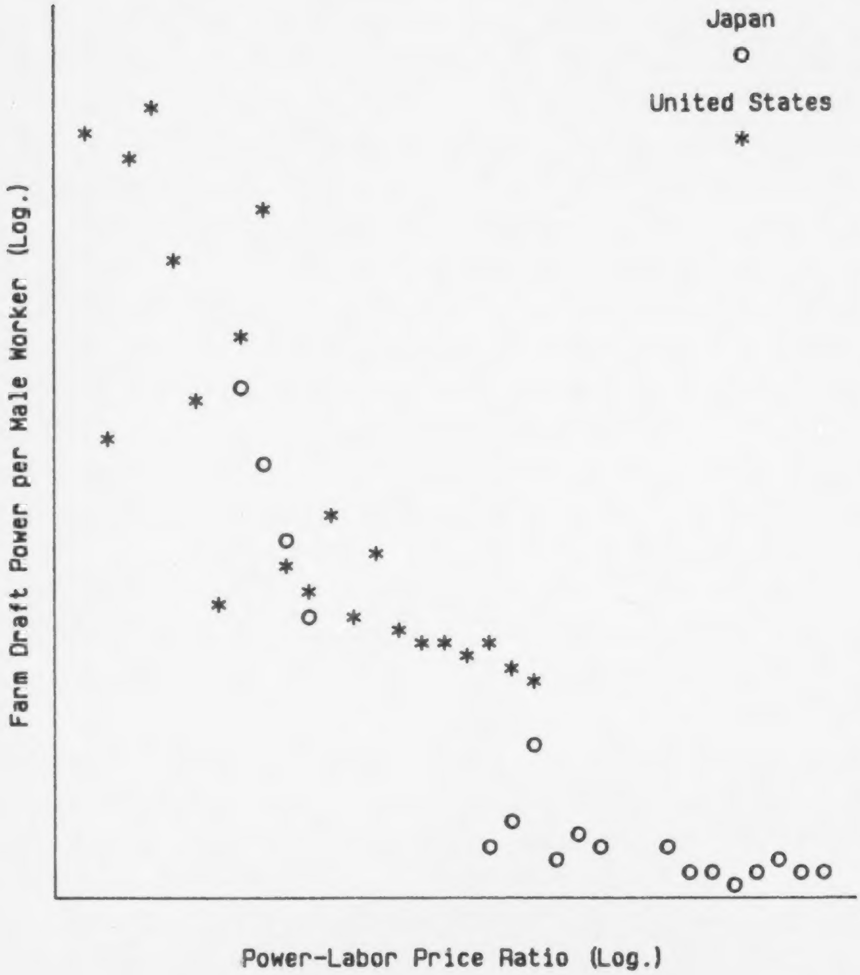

Figure 3 Relation between farm draft power per male worker and power-labor price ratio (=hectares of work days which can be purchased by one horsepower of tractor or draft animal), the United States and Japan, quinquennial observations for 1880-1980. Data from Appendix C, Hayami and Ruttan, *Agricultural Development*, rev. ed. Number of male workers=U3 and J3, Power=U7+U8 and J7+J8, Land price=U19 and J19, Power price=average retail price of tractor per horsepower extrapolated by U21 from the 1976-80 average of $216 for the United States, and extrapolated by J21 from the average of 65,170 yen for Japan

Perspective

In the closing decades of the twentieth century we are approaching the end of the most remarkable transitions in the history of agriculture.

Prior to the beginning of this century, almost all increases in agricultural production occurred as a result of increases in area cultivated. The major exceptions were in *Western Europe*, where livestock-based conservation systems of farming had developed, and in *East Asia*, where wet rice cultivation systems had developed.

But by the end of this century there will be few significant areas where agricultural production can be expanded by simply adding more land to production. Expansion of agricultural output will have to be obtained almost entirely from more intensive cultivation of the areas already being used for agricultural production. Increases in food and fiber production will depend, in large measure, on continuous advances in agricultural technology.

The task before us is clear. It is imperative, *over the next several decades, that we complete the establishment of agricultural research capacity for each commodity of economic significance in each agroclimatic region of the world.*

A developing country which fails to evolve a capacity for technical and institutional innovation in agriculture consistent with its resource and cultural endowments suffers two major constraints on its attempts to develop a productive agriculture. It is unable to take advantage of advances in biological and chemical technologies suited to labor-intensive agricultural systems. And the mechanical technology it does import from more developed countries will be productive only under conditions of large-scale agricultural organization. It will contribute to the emergence of a "bimodal" rather than a "unimodal" organization structure.

During the last two decades a number of developing countries have begun to establish the institutional capacity to generate technical changes adapted to national and regional resource endowments. More recently, these emerging national systems have been buttressed by a new system of international crop and animal research institutes. These new institutes have become both important soures of new knowledge and technology and increasingly effective communication links among the developing national research systems.

The lag in shifting from a natural resource-based to a science-based system of agriculture continues to be a source of national differences in land and labor productivity. Lags in the development and application of knowledge are also important sources of regional productivity differences within countries. In countries such as Mexico and Pakistan, differential rates of technical change have been an important source of the widening disparities in the rate of growth of total agricultural output, in labor and land productivity, and in incomes and wage rates among regions.

Productivity differences in agriculture are increasingly a function of investments in scientific and industrial capacity and in the education of rural people rather than of natural resource endowments. The effects of education on productivity are particularly important during periods in which a nation's agricultural research system begins to introduce new technology. In an agricultural system characterized by static technology, there are few gains to be realized from education in rural areas. Rural people who have lived for generations with essentially the same resources and the same technology have learned from long experience what their efforts can get out of the resources available to them. Children acquire from their parents the skills that are worthwhile. Formal schooling has little economic value in agricultural production.

As soon as new technical opportunities become available, this situation changes. Technical change requires the acquisition of new husbandry skills; acquisition from nontraditional sources of additional resources such as new seeds, new chemicals, and new equipment; and development of new skills in dealing with both natural resources and with the input and product market institutions that link agriculture with the nonagricultural sector.

The processes by which new knowledge can be applied to alter the rate and direction of technical change in agriculture, are, however, substantially greater than our knowledge of the processes by which resources are brought to bear on the process of institutional innovation and transfer. Yet the need for viable institutions capable of supporting more rapid agricultural growth and rural development is even more compelling today than a decade ago.

The Political Economy of Agricultural and Rural Development

Bruce F. Johnston
Stanford University

The term *political economy* went out of fashion decades ago because economists wanted to concentrate on rigorous analysis of the strictly economic aspects of problems. The term has come back in favor, however, for many of us concerned with problems of development. We recognize that we simply cannot afford to ignore the political dimension that is so important to our understanding of the real world problems—and opportunities. Lasswell's classic definition of politics—who gets what, when, and how?—is also a fine definition of the political economy of development. In brief, political constraints are as important as the scarcity of economic resources in determining those things that are feasible and not merely desirable.

In addressing this large topic, I want to deal in summary fashion with three key questions.

My first question is, simply, why focus on agricultural and rural development?

Second, why should we in this country be concerned about the development problems of Kenya, India, and other third world countries?

Third, what have economists in general—and this particular agricultural economist—learned in the last 40 years about the critical elements or ingredients of successful strategies for agricultural and rural development?

I can deal quickly with the first question: Why the focus on agricultural and rural development?

For the less-developed countries that still have very low incomes—the Indias, Kenyas, or Indonesias in contrast with middle-income countries such as South Korea, Brazil, or Taiwan, some 60 to 80 percent of the population and labor force still depend on agriculture for their livelihood—for employment and income.[1] And it is not necessary to dwell on the fact that food is one of the most basic of "Basic Human Needs." (See Mellor and Johnston 1984.)

On my second question, as to why we as Americans should be concerned about the development problems of third world countries, there are many answers. Let me mention two that I find persuasive.

The first answer boils down to this: We are part of the problem and therefore have a moral, a human obligation to try to be part of the solution. The most obvious way in which we are part of the problem is that we—the U.S., the countries of Western Europe, and the World Health Organization and other international institutions (including the Kellogg, Rockefeller, and Ford Foundations)—are mainly responsible for the explosive growth rates of population that became universal among the less-developed countries during the decades following World War II. I am referring, of course, to the opening up of access to immunization programs and other modern public health technologies and to modern medical knowledge. This lowering of death rates—above all by reducing infant and child mortality—has been a blessing for the families that have been spared the wastage of human life when, as was often the case, one out of three infants died before the age of five. Like many transfers of modern technology, however, it has been a two-edged sword. We have learned that it is much easier for external interventions to bring about a rapid reduction in death rates than in birth rates. Clearly, it is the dramatic decline in death rates—from crude death rates of 40 to 50 per thousand to current levels of 10 to 25 per thousand—that has given rise to the explosive growth of population of the past 35 years. (Johnston and Clark 1982, pp. 47-60.)

Again, this is a problem that applies particularly to the low-income countries. It also applies with special force to the countries of tropical Africa—and not only because so many of the low-income countries are in the region. In fact, tropical Africa is the one region in the world where rates of population growth are continuing to increase because death rates are continuing to fall and birth rates are virtually unchanged.

The situation in Kenya epitomizes the way in which the task of raising per capita incomes has been made exceedingly difficult because of the emergence and persistence of very high rates of population growth. During the demographic transition in Western Europe and Japan, the period of rapid population growth was charaterized by rates of increase of about 1.5 percent, compared to an estimated rate of 4 percent in Kenya. It is the nature of population growth to proceed at a compound rate. An upsurge in infant and child survival this year means an upsurge in the rate of increase in women of child-bearing age beginning 15 to 20 years from now. Hence the *momentum* of population growth that demographers emphasize. A growth rate of 4 percent means that a population will double in just over 17 years—and will increase seven times in 50 years. At first glance, a population growth rate of 2 percent doesn't seem all that different—a population doubling time of 35 years instead of 17. But continuation of a 2 percent compound rate for 50 years implies an increase of ''only'' 2.7 times compared to a sevenfold increase with a 4 percent growth rate.

Demographic projections for Kenya offer a striking example. For the 55-year period 1969 to 2024, the ''most likely'' set of assumptions point to an increase in Kenya's population from 11 million to 64 million. Those projections also considered the prospective change in the urban-rural composition of the country's labor force. Assuming continued rapid growth of the urban workforce, the rural workforce is projected to decline from 87 percent of the total in 1969 to 65 percent in 2024. In spite of the projected *sixteenfold* increase in the population of working age in urban areas, however, the rural workforce would still increase *fourfold* over that 55-year period (Shah and Willekens 1978). Those projections emphasize an important *structural* characteristic of countries with rapid population growth and where the share of the population dependent on agriculture is still very high.

But before I turn to the implications of these structural/demographic characteristics on the choice of an agricultural strategy, let me mention another fundamental reason why I believe that it is important for the U.S. to continue to play an important role in providing economic and technical assistance for the contemporary low-income countries. Throughout most of human history poverty was widespread, but it was not perceived as a problem in the way it is today. Instead, it was seen as part of the natural order. "The poor are always with us." Their plight should be alleviated by charity, but poverty was not viewed as a condition that could and should be eliminated by well-designed and vigorously implemented development efforts. However, with the remarkable advances that have been made in *science and technology,* the development goal of eliminating poverty has become a real possibility, not merely a utopian dream. (See Simon 1984.)

I turn now to the question of what economists—and this agricultural economist—have learned about the development process during the past 40 years. And that will bring me back to the implications of those structural/demographic characteristics of today's low-income developing countries.

But first I want to draw on my work in Japan in the years immediately after World War II. With the benefit of a lot of hindsight, I see that I am very fortunate to have been influenced so strongly by Japan's experience as my implicit "model" of agricultural development. During the critically formative period of the late 19th century and the early decades of the 20th century, increases in agricultural productivity contributed in some very important ways to the overall economic development of Japan. (See Ohkawa, Johnston, and Kaneda 1969; Johnston and Kilby 1975, chap. 5.) Three features of that experience were especially significant.

1. Agricultural production was increased within the unchanged organizational framework of Japan's existing small-scale farming system. Between 1880 and 1960, Japan's agricultural production increased about 3-1/2 times, slightly more than the increase in the U.S. over the same 80-year period. Because of technological change, specifically increases in the productivity of the existing on-farm resources of land and labor, this was achieved with remarkably small demands on the critically scarce resources of capital and foreign exchange.

2. Most of the nation's farmers were involved in increases in agricultural productivity associated with the use of improved crop varieties, fertilizers and other types of working capital—but remarkably little investment in farm machinery or other types of long-term capital investment. *Technological change* related to high-yield, fertilizer-responsive crop varieties was the driving force in increasing agricultural productivity. And the technical innovations and new purchased inputs were *divisible*. Therefore they could be used efficiently by small farmers subject to a severe purchasing power constraint. And the typical farmer unavoidably faced a purchasing power constraint. The cash income accruing to the agricultural sector was limited because of the structural/demographic characteristics emphasized earlier. When the number of farm households is still large relative to the domestic population dependent on purchased food, the cash income accruing to the average farm unit is inevitably small. When a country's pattern of agricultural development is *dualistic,* so that a relatively small number of atypically large and capital-intensive farm enterprises account for the lion's share of commercial production, those large farms escape the purchasing power constraint. But that is at the expense of intensifying the cash income and purchasing power constraint for the great majority of small farm units.

3. Agricultural and industrial growth went forward together in a process of concurrent growth. As the overwhelmingly agrarian character of the Japanese economy was gradually transformed by the process of economic growth, there were positive interactions between agriculture and industry. Moreover, the concurrent progress in agriculture and industry led to decentralized industrial development of a "semi-modern" industrial sector that relied upon relatively simple, capital-saving, labor-using technologies, which made possible more rapid growth of output in both sectors.

I want to dwell particularly on the first and second factors and the importance of *technological change.* All of the speakers in this seminar series are, I believe, in agreement on the great importance of technological change. This potential importance of technological change as a source of agricultural growth has some very important implications for the design of development strategies.

One terribly important implication is that we need to be as concerned with investments in human and institutional resources as in physical investments such as construction of irrigation systems or building factories for manufacturing farm equipment. James Bonnen, a distinguished professor of agricultural economics at Michigan State University, has emphasized that agricultural progress in the U.S. has been the result of interactions within a *system* of developmental institutions: farmers and their organizations, the United States Department of Agriculture and the land-grant colleges and universities, the Federal-State Agricultural Research and Extension programs, private sector firms engaged in the marketing and processing of farm products and the manufacture and distribution of farm inputs, and the federal and state political institutions involved in the formulation of agricultural policy. (See Bonnen 1987.) Experience in the U.S., Japan, Taiwan, and many other countries has demonstrated that efficient agricultural progress depends on the interacting effects of farm-level factors and what, for lack of a better term, I refer to as socially determined factors. The farm-level factors include the responsiveness of farmers to incentives and their investments of time and money in land improvement, in equipment, in fertilizers and other forms of working capital, and in acquiring knowledge and skills. The socially determined factors include educational institutions, investments in agricultural research, extension, and infrastructure, macroeconomic policies (e.g., monetary policy and interest rates), and a host of factors affecting the marketing of farm products and the distribution of inputs.

The twofold implication of recognizing the great potential importance of technological change concerns the need for investments in the various forms of capital—physical, human, and institutional—to be reasonably well-balanced. It is easy to state the economic principle. The rate of return on the last dollar invested in each type of capital should be approximately equal. But to realize that ideal in practice is enormously difficult. The emphasis by Hayami and Ruttan (1985) on "induced innovation" and the importance of avoiding price distortions is an important part of the answer. However, the decisions to make the long-term investment in building supporting institutions, including educational institutions to train agricultural scientists and administrators, requires a vision, even a faith, that goes beyond perceiving trends in relative prices. Lessons of past historial experience can be enormously helpful—provided that they are well understood and properly interpreted. I believe that I have been very fortunate to have had an opportunity to learn about Japan's experience when I was still very young and impressionable. Every country confronts a unique set of problems. But I am persuaded that Japan's past experience is of much greater relevance to today's developing countries than the historical experience of the United States.

Another important lesson of past experience concerns the relative advantages of the public and private sectors in achieving successful agricultural development. The first proposition that I would stress is that we have to move beyond a doctrinaire faith in either government planning and direct action by government, or the equally blind faith in the private sector and "the magic of the market place." Experience in the U.S., in Japan and in many other countries demonstrates that successful agricultural development depends on an interacting system of public and private institutions.

There are good theoretical reasons and much evidence to support the view that independent private firms have a comparative advantage over public agencies in carrying out essentially *commercial* functions such as production or marketing farm products or distributing farm inputs. This is essentially because the hierarchical techniques of decisionmaking and operating within a bureaucracy are at a disadvantage as compared to the greater flexibility and the capacity and motivation for cost-minimization that characterize private firms responding to price and profit signals within a market system. It is equally important to stress, however, that a number of the socially determined factors that are of critical importance depend upon the public sector. This is because public agencies are needed to make available critical public goods such as education, agricultural research, extension, and family planning services. It is a defining characteristic of public goods and services that they will be provided in less than the socially optimal amount if their availability depends on private firms responding to private demands. Even from a strictly economic point of view, society's benefits from investing in education, for example, exceed the private returns accruing to those who receive the education.

Finally, I want to make a few comments about the role of food aid. This is a complex and controversial topic. Some people who stress that the world's food problems are ''merely a matter of distribution'' conclude that *sending* our ''surplus food'' is a neat and simple answer. Food aid shipments *are* essential for famine relief. They are *not* the answer to the fundamental problems of poverty. And it is their poverty that makes poor countries so vulnerable to famine.

I sympathize with the prime minister who wanted to find a one-handed economist because he (or was it she?) was fed up with ''on the one hand, on the other hand'' answers. But there's no getting away from the complexity that characterizes food aid. Food aid can be used to promote development. It can and, I believe, often does have adverse effects on incentives to increase food production in a low-income, developing country. But rather than spend a lot of time trying to spell out the conditions that have to be fulfilled in order for food aid to have a positive impact, let me give you, as an illustration, my view on the food aid balance sheet for India. It seems to me that for the 1950s and up to the mid-1960s, it is difficult to say whether food aid yielded significant net benefits for India. Its greatest value was probably in saving foreign exchange that could be used to finance other imports including, for example, equipment for fertilizer factories and for irrigation facilities. But its availability undoubtedly had an adverse effect on farm prices and farmers' incentives. In addition, it probably weakened the resolve of the government to face up to the country's agricultural problems. There is no doubt in my mind that dollar-for-dollar the food aid was less valuable than, say, the investments that enabled some of our land-grant universities to assist in establishing a network of agricultural universities in India and in creating a more effective national agricultural research system. But that ignores two important political economy dimensions of the issue.

First, there is no doubt that to *some* extent the food aid was *additional* to other forms of aid. As long as agricultural ''surpluses'' are created as a by-product of our agricultural price support programs, there is bound to be pressure in Congress to convert those "costly and burdensome surpluses" into a "valuable food resource." Second, I am convinced that the blunt way in which Lyndon B. Johnson carried out his "short tether" policy in making aid available to India during the acute famine in 1966 and 1967 resulting from two successive years of drought had powerful and positive consequences. There was great resentment among Indian politicians, policymakers, and officials at many levels at being treated in that way, e.g., in imposing many harsh "conditions precedent." Indeed the Indians involved were so infuriated that the episode created a resolve to never again be so dependent on food relief shipments. And fortunately the prior investments in strengthening India's human and institutional resources as well as U.S. and World Bank investments in expanding irrigation facilities and fertilizer manufacturing capacity meant that India's interacting system of developmental institutions could meet the challenge of virtually ending India's dependence on imported food.

In recent years, there has been a very substantial increase in food aid to countries in sub-Saharan Africa (Johnston et al. 1987, chap. 2).[2] Because of the tight budget situation in the U.S., together with current concern over the financial difficulties of American farmers as a result of the recent decline in agricultural exports and in farm prices, there is pressure to further expand food aid shipments; and exaggerated claims are being made about the benefits to be realized from such shipments. (See, for example, Reutlinger and Katona-Apte 1987.) Providing food aid as a substitute for commercial imports would help to ease the serious balance-of-payments problems faced by countries in Sub-Saharan Africa. As noted by Timmer in his chapter, however, using food aid to replace commercial imports is contrary to the intent and the regulations that are supposed to govern food aid programs of the U.S. and other countries. Moreover, sustained solutions to Africa's serious food and agricultural problems require economic and technical assistance to support the strengthening of national agricultural research systems and postsecondary educational institutions for training agricultural scientists and administrators, together with investments in expanding, rehabilitating, and maintaining rural transport networks and other rural.

infrastructure. Use of a certain amount of food aid for rural works projects could have a positive developmental impact, although such projects make substantial demands on scarce administrative and planning capacity. It is essential to recognize that food aid cannot be a substitute for supporting the long-term institution-building that is so desperately needed in Sub-Saharan Africa.

NOTES

1. The distinctive problems of such "late-developing" countries are examined in Johnston and Kilby (1975) and Johnston and Clark (1982).

2. For historical reasons, Africa has not been the focus of U.S. economic assistance. Since 1978, U.S. assistance to Africa has amounted to a little over 10 percent of the country's foreign aid to all regions; but prior to 1978, Africa received only about 5 percent of the total. For the six countries—Senegal,Nigeria, Cameroon, Kenya, Tanzania, and Malawi—included in the World Bank's study of Managing Agricultural Development in Africa (MADIA), AID's bilateral assistance for projects and programs during the period 1963-84 amounted to $905 million in constant 1983 dollars or only a little more than the $836 million provided as food aid (Johnston et al. 1987, chap. 2, table 3).

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Foreign Assistance and Agricultural Development

Implications of the Past 25 Years for Policy Conditionality, Capacity Building and Sustainability

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Why should we be interested in understanding the interactions of foreign assistance with the agricultural development of developing countries? First, because foreign assistance plays a major role in the expenditures of low-income developing countries. In Africa currently, from 30 percent to 60 percent of government expenditures in many countries come from foreign aid, and the share of government expenditures in the Gross Domestic Product (GDP) of African countries ranges from 25 percent to 35 percent. Even in a large country such as India, at its peak foreign assistance constituted close to a quarter of the gross domestic investment.

Second, development of the agricultural sector plays an important role in the overall economic development of countries at early stages of development, and governments need to play an important role in developing agriculture due to the "public goods" nature of many investments such as agricultural research, extension and physical infrastructure. These investments require lumpy capital and skills for their development. Small farmers with low incomes cannot mobilize resources on their own on a scale needed to establish such infrastructure, especially as the benefits derived from such investments have long gestation lags. Besides, they are not easily captured and recovered through direct cost recovery, hence the important role for government at early stages of development.

I am grateful to Paul Fishstein for research assistance and to Kim Tran for typing the paper.

Third, the contribution of foreign assistance to government activity consists not simply of financial transfers, but also of the transfer of ideas in the form of policy advice, skills provided through technical assistance which accompanies investment decisions, and institutional development through such means as the transfer of western "models," as for instance the U.S.-type land-grant colleges for agricultural research and extension. These various nonfinancial transfers can have a profound effect on the efficiency with which financial resources are utilized by the recipient countries and thus on the pace of growth of production and productivity. The level, stability and content of foreign assistance are strongly influenced by the international economic and political environment. It is important to explore the important dimensions of this environment to see its impact on the nature of foreign assistance as well as on its effectiveness.

The process of agricultural development is, however, in large measure determined by the resource endowments, policies, institutions and technological possibilities in the recipient countries. The extent to which an environment conducive to agricultural development exists depends largely on the way policymakers in developing countries perceive the role of the agricultural sector, and the extent to which they put in place the means to foster development.

The African situation offers a good example of the interaction between domestic and international factors. The problems of African countries' agricultural sectors have been at the center of international attention since the late 1970s because of the broadly shared international view that domestic policy failures largely explain their slow pace of development. Much "aid weariness" has developed because of the perceived failure of foreign aid to solve the problems of agricultural development in Africa. In the 1950s and 1960s, countries in Asia went through similar periods of balance-of-payments crises resulting from the failures of their agricultural exports and increased food (and industrial) imports. They too were seen to be increasing their dependence on food and financial aid from developed countries and there did not seem to be any hope of their ever being able to reach the stage of food self-sufficiency and sustained agricultural growth. Many of them, such as India, Pakistan, Indonesia and even Bangladesh, have now reached a position of food self-sufficiency, and some (e.g., India, Pakistan and Indonesia) have become modest exporters of food. Important insights can be derived from the experience of Asia regarding the content of foreign aid, and especially the way it affected domestic policies, resource endowments and institutions, which in turn enabled Asian countries to develop agriculture. It is interesting to consider whether parallel possibilities exist in Africa.

There has been reluctance to indulge in such comparative analysis on grounds that few useful lessons can be learned from Asian countries which had far superior initial endowments in the form of trained manpower and institutional capacity. These may not be reproduceable in the African countries. A great deal of foreign aid to Africa, on the other hand, has already involved a relatively simplistic application of far more advanced western technologies, institutions and changing conceptions of development. The effects of aid from OECD countries to African agriculture over the last quarter-century constitute the subject of a major research project under my direction. Also, in providing such aid, frequently the wrong lessons have been learned from the Asian experience and applied to the African continent. For instance, the Indian type of complex, centralized, multisectoral planning models were trendy in the 1960s and were applied in Nigeria's early plans by western advisors. Concern about increased inequalities following the Green Revolution in Asia resulted in donors in the 1970s placing an excessive emphasis in Africa on integrated agricultural development of the regions and populations with few resources and growth possibilities in the short run. Such investment in agricultural and rural development resulted in a large number of failed projects leading neither to growth nor equity. Similarly, the concerns about the growing ranks of the educated unemployed derived from the Asian experience in the 1970s lead the international development community to underrate the fundamental importance of investment in education and training in African countries in the advice and investments they offered.

Since the technological, institutional, skilled manpower and physical resource endowments of many Asian countries are closer to those of

Africa in some respects than the solutions derived directly either from the West or from these various western perceptions of the relevance of the Asian experience to Africa, it might be fruitful to make direct comparisons between the two continents to determine more precisely where lessons are transferable and where they are not. For instance, semi-aridness is a major reason for Africa's poor agricultural performance. India has two-thirds of the world's cultivable area that is classified as semi-arid and Africa has one-third. It is instructive, therefore, to examine where growth in agricultural production occurred in India and why, and to examine the implications for Africa's prospects in semi-arid agriculture. Similarly, small-scale irrigation and low-level agricultural technology used extensively in Asia can benefit Africa in place of the tractorized schemes and large-scale irrigation dams financed by foreign aid to date. As a prototype of the Asian case, I will explore the sources of growth in India's agriculture, the causes of that growth, and the role that foreign aid has played in that process to derive insights for the development of African agriculture. To do so, I first review the international economic environment which currently determines the level, size and sources of foreign aid to Africa and which influenced these levels in India. I then outline briefly the motivations of aid as they determine the type and certainty of aid. This in turn influences the extent to which recipient country policymakers feel that they can rely on external financing as a source of government expenditures. I then examine the role of agriculture in economic development. Afterwards, by reviewing India's agricultural development experience and the role of foreign assistance in the process, I identify the sources of India's agricultural growth and the causes of that growth. I then examine the similarities and differences in the domestic policy environments and aid between the African countries and India to draw implications from the comparative experience for future agricultural development in Africa.

The International Environment for Aid

The rapid growth in agricultural production in North America, Europe and Japan since the mid-1970s has greatly increased the world surplus stocks of grain in the 1980s. This situation is radically different from the period in the 1960s when India was the major beneficiary of concessional aid. Then the United States was the only major source of surplus food and foreign aid and thus the dominant source of advice, institutional innovations and new technological possibilities introduced in the agricultural sector in India. The sources of aid to the developing world have greatly diversified since then, as has the prosperity among western nations. For instance, a large number of Western European countries and Japan as well as Eastern Bloc countries are giving concessional assistance to Africa. Consequently, ideas in the form of policy advice, investments, and institutional and technological possibilities and skills introduced through foreign aid into African agriculture are highly diverse, frequently creating much confusion on the African scene. This is especially the case as the ability of African governments to distinguish between the quality of advice and assistance is greatly limited due to their own limited capacity in terms of trained manpower and institutions.

While the sources and levels of food and financial aid have increased steadily until the early 1980s, they also contain the danger of providing a false sense of security to the recipients, reducing the urgency of dealing with domestic policies which often inhibit the development of agriculture. Concessional aid levels to Africa have declined from 1984 levels as a result of concern about aid effectiveness and also the recessionary trends in OECD countries. Willingness of the African governments to adjust their domestic policies has in turn been influenced by their concern about the decline in aid level and also by the need for increased national self-reliance. The differing views of the diverse donors adds to the confusion on policy adjustments in Africa.

While the broad general directions of policy reforms are clear enough, there is much disagreement as to the speed with which such reforms can be implemented, the size of benefits that will ensue from the reforms and the speed with which the benefits will accrue. The large agricultural surpluses of the OECD countries have changed the international markets and prices by causing a downward pressure on world agricultural prices; this has been reinforced by the countries in Asia becoming exporters, a situation which did not exist in the 1960s. Developing countries of

Africa on the one hand face lower real prices for their agricultural exports due to these surpluses of commodities such as sugar, edible oil, etc., and on the other hand suffer from the competition of low-cost imported cereals. Meanwhile, their own domestic food production constitutes the major source of employment and income for a great majority of their populations, with over 60 percent of their cultivated area under cereal production. Cheap food imports can increase the real incomes of urban populations, but by depressing internal terms of trade they can reduce the incomes of agricultural producers in developing countries, especially if there is no growth in the productivity of their agriculture to compensate for these price declines. If African countries, in addition, face large deficits in their balance of payments resulting from a combination of their own failed import-substituting industrialization policies of the 1970s and also the recessionary world market forces referred to above which have reduced the prices of their exports, this explains the need for macroeconomic reform in their countries to adjust to the changing world market. An increase in the domestic agricultural factor productivity which will reduce the cost of African production and make it more competitive with cheap agricultural imports or exports of competitors is thus the most important way to avert further decline in the real incomes of African countries.

Motivations of Aid

Aid is prompted by many reasons. Recipients have preferred to think of aid much in the way that Senator Fulbright considered it, namely, as a form of progressive international taxation in which a small share of the income of high-income countries is mobilized and transferred to their low-income counterparts for the latter's development. Since developing countries are dependent on primary commodity exports, the prices of which fluctuate more than those of manufactured goods and services exported by developed countries, these countries have argued for aid so as to stabilize their export income. The concept of aid as a form of income transfer, however, has not had a broad appeal in the

United States, although a large majority tends to be in favour of emergency aid on humanitarian grounds. Public opinion surveys show, for instance, that while 79 percent of those interviewed in the U.S. approved of emergency aid only 49 percent supported *long-term* development assistance.

Aid, is course, also given by developed countries to meet their strategic, military or foreign policy concerns. In the case of aid programs of the United States, this has often resulted in assistance being highly concentrated on a few countries of the world, regardless of their developmental needs. U.S. aid levels to specific countries have also been quite unstable, depending on changes in those foreign policy or strategic considerations. Aid given to create long-term markets for the goods and services produced in the developed countries has more recently simply resulted in the disposal of surpluses existing in the OECD countries in the form of commodities, trained manpower or underutilized industrial capacity. Such desire for surplus disposal frequently results in tying of financial aid to the supply of equipment or trained manpower of the donor country, which may not be the most desirable for the development of recipient countries.

Motivations for aid may thus greatly affect the size, as well as the form and stability, of aid. Aid-giving countries may also refuse to share the secrets of their success so as to avoid future competition from recipients. Aid may thus increase dependence of recipients in the short run without the possibility of its leading to self-reliance in the long run. This is, of course, a greater problem with bilateral than multilateral aid such as that of the World Bank, which is not tied to a particular source and is not related to strategic and military interests of individual countries.

Interaction of Foreign Aid with Domestic Policies

We now move on to consider the interaction of the level, form and stability of aid with the motivations for aid and its effects on the domestic policies of recipient countries by taking the example of India. Nearly 60 percent of the $10 billion of U.S. aid received by India between 1949 and 1982 was given in the form of food aid, another 20 percent in the form of nonproject aid, and only 17 percent in the form of project loans. Bilateral assistance by the U.S. to India was relatively low until about 1958, accelerated sharply to a peak in about 1968, and then declined sharply, especially from about 1972, to the point of becoming insignificant. Given its large size (750 million population), aid levels to India, on a per capita basis, have been very low—at their peak in 1965-66 being $2.6 compared to $20 to $50 per capita in many African countries currently. Only about 12 percent of these expenditures was on agricultural projects, most of a small-scale nature.[1] This situation is in contrast to that of many African countries in several ways. First, in Africa not only is the overall level of aid much higher, but the dependence on food aid is very small in comparison with India's. Food aid constitutes only about 10 percent of total aid to Africa, compared to over 50 percent of U.S. assistance to India. Much of the aid is in the form of financial aid and also in the form of projects. In contrast, much of the U.S. assistance to India was in the form of commodity or program aid and only a small amount in project aid. Project aid in Africa has tended to tax the limited planning and implementation capacity of the countries, as the resources devoted to developing such capacity further have been relatively limited, unlike in India. Also, quite a significant amount of technical assistance has been provided to help in the implementation of projects. It is estimated that close to $4 billion were committed by OECD countries in the form of technical assistance to Africa during the 1970s.

Relatively little of this technical assistance has been allocated to improving domestic policy, planning and implementation capacity. Indeed, much of the "learning by doing" has involved the technical assistance staff and, due to their short tenures, there has been much loss of learning by doing. This is an especially serious problem given that African countries start from a poorer initial base of trained manpower and institutional development that did India. In India, only about 1,400 U.S. agricultural advisors are estimated to have resided on a long-term basis from 1952 to 1973, and never more than 150 advisors at any given point in time. Only about 3,200 Indians were trained in agricultural and natural resource issues during this period. These numbers do not seem large in relation to India's size and needs. Yet there is a general belief that the U.S. made an important contribution to India's agricultural development.

I argue in this paper that it is the quality and the form of assistance which was the basis of this contribution and it is the nature of the interaction of aid with domestic agricultural and overall policy which explains the success. The contributions appear to be in the form of: (1) developing of indigenous human and institutional capacity for agricultural research, policy, planning and evaluation, and (2) input into the formation and implementation of an overall agricultural policy which would be conducive to growth. We will stress that the initiative for improved policy and planning ultimately came from India. The successive droughts, increased dependence on foreign aid and external interference in domestic policy affairs from about 1958, when foreign aid accelerated, until about 1965 when it reached a crescendo for India to reform its agricultural policies and to put in place a package of internally consistent reforms which would increase production led to this initiative. Good luck also played a part. Apart from India's obviously better institutional and trained manpower base, the existence of technologies it could import as well as the institutional models for technology generation it could borrow and install at home made a difference to its prospects. Finally and of considerable importance, India had been experimenting with different policies since the early 1950s and there was much accumulated learning through this process; when the crisis arose in the mid-1960s, India was able to utilize this valuable learning experience. We will show that these preconditions are not enjoyed by Africa to the same extent.

Until about 1963, India pursued a growth strategy which stressed an import-substituting industrialization policy in which agriculture had a relatively small role. During the first three plan periods the proportion of investments going to the agricultural sector ranged between 6 percent to 10 percent. India has been broadly criticized for keeping its agricultural prices low prior to 1967.[2] Our analysis indicates that Indian prices were well above world market prices for wheat between 1957 to 1972, however, even when measured in real effective exchange rates (see Figure 3). Only in the case of rice were prices below international prices prior to 1967.

Programs for the development of agriculture, however, tended to focus on community development and extension programs aimed at convincing farmers to adopt modern technology. But the most important factor to be emphasized is that the physical response of production to fertilizers was relatively low for the traditional varieties of wheat and rice (Desai had estimated fertilizer response coefficients of 12kg per 1kg of nutrient for irrigated wheat under local conditions, the equivalent coefficients being 10kgs for rice). It is noteworthy that despite the impressive annual growth rate of nutrient use of 19.8 percent annually, the average annual rate of growth for foodgrain output was about 3 percent per year during this period and there were substantial year-to-year fluctuations in overall production that tended to be influenced largely by weather. Dependence on imports had increased to meet domestic food requirements. Figure 1 shows the domestic availability of food grains including the rising imports in the mid-1960s. Figures 2 and 3 show the relationship of domestic to international prices of rice and wheat in India and illustrate the less favorable treatment of rice in terms of international prices as well as relative to wheat. Figure 4 shows the growth of fertilizer use in India. While India's dependence on financial assistance had increased by 1958 as a result of a foreign exchange gap created by an ambitious second plan and aggravated by the persistent need for commercial food imports, by 1966 net food imports had grown to over 10 million tons.

The role of price policy reform vis-a-vis other agricultural policies is worth considering in the context of India's agricultural growth since 1967. President Johnson believed that India was not serious about an agricultural policy reform. Further support for India's development by the U.S. and the World Bank, which had begun to emerge as a major donor, was contingent on India's devaluating its currency as well as a package of policies for the agricultural sector including increased producer prices for rice and wheat, increased imports of fertilizers and promotion of their role for the private sector and concentration among the progressive farmers in high potential areas, and support of prices for

Figure 1
Availability of Foodgrains in India

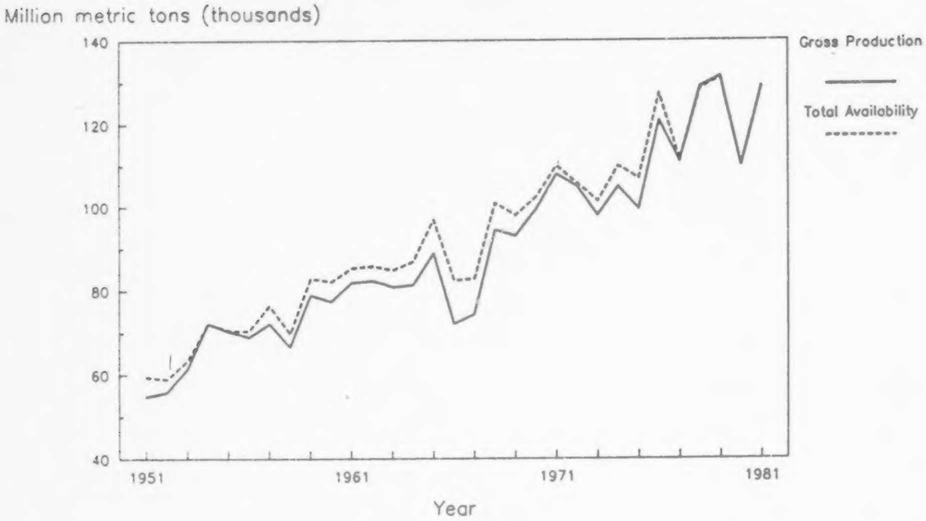
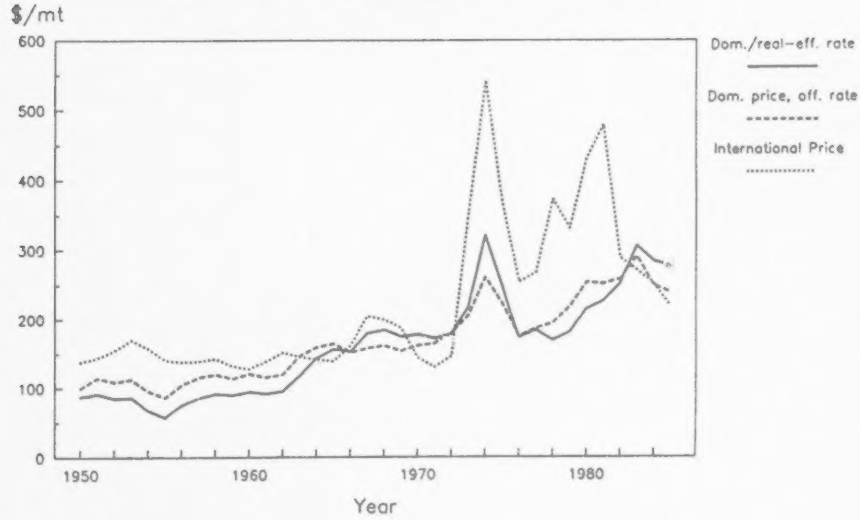


Figure 2
Domestic and International Price of Rice



the agricultural sector by a newly established food corporation of India becoming the buyer and seller of last resort. Many of these policies are similar to those now being advocated in African countries. It has generally been the U.S. belief that the imposition of these conditions on India in the mid-1960s as a prerequisite for receiving financial assistance from the U.S. and the World Bank, codified in the "Treaty of Rome" between the Indian minister of agriculture and the U.S. secretary of agriculture, had a profound impact on India's food situation.

Indeed, frequently the 1965 episode in India is cited in the context of the current discussion on policy reform in Africa, suggesting that achievement of the same policy reform in Africa, if necessary through the same type of conditionality, might solve Africa's problems.

There are, however, several important differences between the Indian and African cases which are worth highlighting.[3] First, much of the productivity growth in India occurred under irrigated conditions. In contrast, only 6 percent of the area under cultivation in Africa is irrigated. Not only was India's initial base of irrigated agriculture larger (18 percent of the area under cultivation being irrigated), but the new high-yielding technologies induced further investment in irrigation. Second, the high-yielding rice and wheat varieties used in India were the result of major technological breakthroughs which had occurred in the international agricultural research institutes. In the case of wheat, this resulted in a Nobel Peace prize for its discoverer. Estimated response coefficients of high-yielding wheat under irrigated conditions are 20kgs per kg of nutrient, or 66 percent larger than under traditional varieties and of rice 15kgs, or 50 percent higher than traditional varieties.

Even then, the political decision to concentrate the use of fertilizer in limited areas of high potential was a difficult decision for the Indian government. I have documented elsewhere that there was internal opposition to this approach from almost every important Indian lobby, including the intellectuals, the communists, the state governments, who would not gain from such concentration, the planning commission, because it would require increased foreign exchange, etc. Nevertheless, subsequent fertilizer use in India was highly concentrated in high potential areas.

Figure 3
Domestic and International Price of Wheat

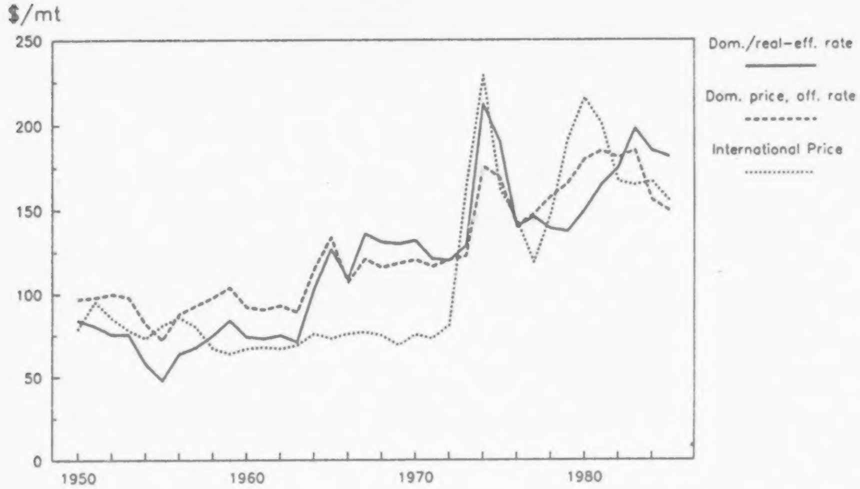
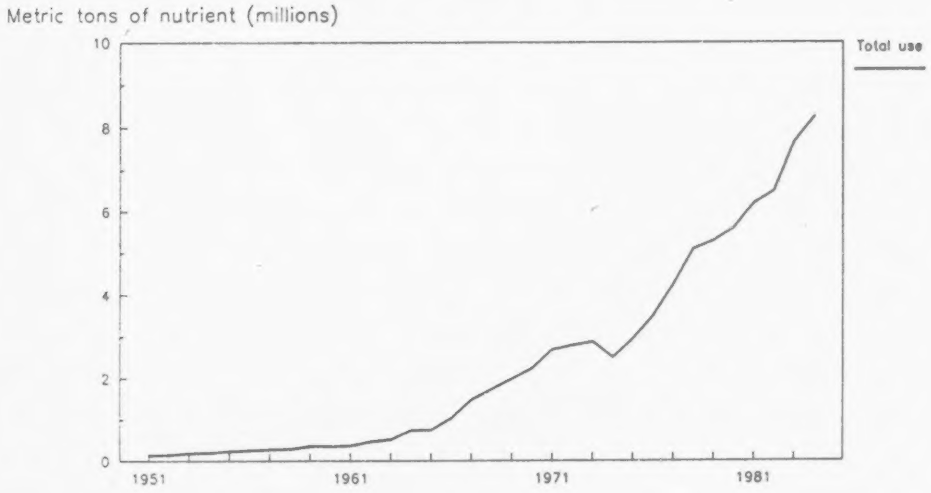


Figure 4
Growth of Fertilizer Use in India



Most important, with the assistance of the Rockefeller and Ford Foundations and the U.S. government, India had been attempting to build up its agricultural research system starting as early as the late 1940s. The food crisis, however, provided the basis for pushing through difficult policy decisions with regard to the research system's reorganization that had been stalled for nearly 20 years due to the internal resistance to reform. Therefore with the advent of the food crisis, India was able to put into operation an effective research system. This made the subsequent adjustments to continue to maintain its productivity gains possible. Such an adaptive research capability is particularly important in the case of crops which encounter highly diverse growing conditions and which therefore require a high degree of local adaptation. This was the case with regard to rice. The Indian research system was ultimately able to issue 221 varieties of rice to address the many diverse adoption problems faced in the promotion of new rice varieties.

Table 1 shows that irrigated wheat alone accounted for an astonishing 99 percent of the increase in productivity during the 1968-69 to 1981-82 period. Rice contributed another 15 percent. During the earlier 1956-57 to 1968-69 period, wheat and rice had contributed 89 and 79 percent respectively to increased productivity. Because the contribution of other rainfed crops to the overall growth in production such as millet, sorghum, maize, etc., which are the dominant crops in Africa as well, was nil or negative (meaning the area under cultivation of these crops declined due to competition of higher productivity crops), the combined contribution of wheat and rice accounted for over 100 percent of aggregate productivity growth. There was a complex input substitution with the new technology. In the rainfed areas, the new technology increased productivity from irrigation more and the spread of minor irrigation, particularly from tubewells, was very rapid. Whereas tubewells accounted for only about 6 percent of irrigated area in 1960-61, they accounted for about 14 percent by 1970-71 and 20 percent in the mid-1970s. In the irrigated areas, use of fertilizer accelerated as the marginal productivity of fertilizer curve shifted upwards and flattened out at a much greater input level. But because use of fertilizer on rainfed areas grew slowly, total fertilizer use increased at an annual rate of about 12 percent, slower than before. It is noteworthy that the foodgrain produc-

Table 1
Crop-Wise Contributions of Individual Effects to the Change in Aggregate Productivity by Period

(Rupees per hectare)

Crop	1956/57 to 1968/69						
	Pure yield effect	Pure location effect	Location interaction effect	Pure cropping pattern effect	Cropping pattern interaction effect	Sum of effects	
Bajra	3.53	-0.23	-0.03	-2.09	0.14	1.37	(0.78)
Barley	1.54	-0.06	0.20	-10.03	-0.97	-9.32	(-5.33)
Cotton	2.81	0.05	-0.07	-33.44	0.55	-30.10	(-17.20)
Groundnuts	-1.36	0.16	0.18	14.48	-2.57	10.89	(6.22)
Jowar	-0.16	0.18	0.01	-4.15	-0.17	-4.29	(-2.45)
Maize	1.17	0.09	0.19	19.39	2.29	23.14	(13.22)
Pulses	2.11	1.40	-.068	-15.87	0.20	-12.83	(-7.33)
Ragi	0.03	-0.01	0.01	-3.68	0.10	-3.54	(-2.02)
Rice	25.45	0.88	0.00	16.24	7.71	50.09	(28.62)
Sugarcane	0.77	0.37	0.00	-1.03	0.15	0.25	(0.14)
Small millets	-0.09	-0.01	0.02	-6.49	0.09	-6.48	(-3.70)
Wheat	20.05	1.23	1.42	95.12	38.00	155.82	(89.05)
Total	55.86	4.04	1.12	68.45	45.52	174.99	(100.00)
	(31.92)	(2.31)	(0.64)	(39.12)	(26.01)	(100.00)	

Crop	1968/69 to 1981/82 Pure yield effect	Pure location effect	Location interaction effect	Pure cropping pattern effect	Cropping pattern interaction effect	Sum of effects	
Bajra	0.72	–0.24	–0.45	–6.65	–0.17	–6.80	(–2.57)
Barley	1.10	0.21	–0.14	–15.37	–2.45	–16.66	(–6.29)
Cotton	3.77	1.08	0.20	–4.64	–2.65	–2.23	(–0.84)
Groundnuts	2.66	–0.06	0.83	–9.50	–0.39	–6.46	(–2.44)
Jowar	6.69	–0.31	–0.11	–7.46	–1.66	–2.86	(–1.08)
Maize	0.07	0.20	0.20	–9.31	0.09	–8.74	(–3.30)
Pulses	–1.15	–1.88	0.69	6.23	0.44	4.33	(1.64)
Ragi	2.05	–0.09	–0.03	–1.61	–0.20	0.11	(0.04)
Rice	20.41	3.51	1.50	10.88	3.01	39.30	(14.84)
Sugarcane	0.56	0.17	–0.01	12.33	0.51	13.57	(5.12)
Small millets	0.30	–0.22	0.08	–10.25	–0.16	–10.25	(–3.87)
Wheat	32.07	2.93	0.40	206.01	20.11	261.51	(98.75)
Total	69.24	5.28	3.15	170.65	16.49	264.83	(100.00)
	(26.15)	(1.99)	(1.19)	(64.44)	(6.23)	(100.00)	

SOURCE: Bindlish (forthcoming).

( ) Indicates percent of the sum of the effects for the period.

tion growth rate accelerated to 3.5 percent annually during 1965-66 to 1976-77, despite the deceleration in fertilizer growth rate by over 40 percent to 12 percent annually. This would suggest an improved efficiency of fertilizer use brought about by two related factors: technical change in the form of the new grain varieties with higher fertilizer response coefficients and an acceleration in the rate of growth of irrigation (table 2) induced by the enhanced profitability of the new varieties.

Table 2
Growth Rates for Foodgrain Production, Fertilizer Use and Irrigated Area

	Foodgrains		Fertilizer	Irrigated area	
Period	Annual %	3-yr. avg. %	Annual %	Gross %	Net %
1951/52 - 64/65	3.03	2.97	19.84	2.14	1.95
1965/66 - 76/77	3.83	3.54	11.78	3.11	2.71
1977/78 - 84/85	2.65	2.32	9.06	2.64	1.88
1951/52 - 84/85	2.89	2.86	16.06	2.74	2.22

SOURCES: "Area and Production of Principal Crops in India," Government of India; "Fertilizer Statistics," The Fertilizer Association of India.

NOTES: Information on foodgrain production was available only through 1983-84. Information on irrigated area was availably only through 1981-82. "Annual" refers to a simple yearly series, while "3-yr. avg." refers to a three-year moving average series. Irrigated area rates use an annual series.

Finally, since the U.S. was the only supplier of food and since its reserves were declining rapidly, India realized that, should a deficit arise, increased reliance on the U.S. for food imports was likely to be unwise, as it would result in increased world food prices given India's large food import requirements. It was also injurious to national pride, as it would compromise India's pursuit of an independent foreign policy because of the dependence on scarce U.S. stocks. Thus Indian policymakers were able to overcome a number of formidable domestic obstacles to reform, although the individuals involved in the reform paid a substantial cost. (Mr. Subramaniam, the minister of agriculture, for instance, lost the election in 1967 because of a perception that he had become too pro-American.)

The current discussion of macroeconomic and sectoral policy conditionality tied to financial aid of donors in Africa, as well as the increased food imports, are reminiscent of India's situation for those involved in such assistance earlier. Nevertheless, many differences exist, although many African countries have devaluated, revised their food prices and liberalized fertilizer imports and distribution as did India. There have been relatively few technological breakthroughs in the case of crops grown in the semi-arid areas of either Africa or India, however. The exception is hybrid maize, which has shown impressive growth in many parts of Africa where similar effective services in the form of timely fertilizer supply, extension and output marketing facilities have been available. Some technological possibilities exist, but require effective adaptation of varieties and practices to local conditions such as that done by the Indian research system in the case of rice earlier. The national research systems of most African countries, with the exception of Zimbabwe and Kenya, have not shown the capacity to organize adaptive research programs which would lead to the production of more suitable planting material.

Unlike in India, donors who have focused on project aid until recently have neglected the development of national research systems; contrary to much conventional wisdom on the subject, they have assumed that borrowing technology from the international research systems and conducting on-farm adoptive research without building the national research system which will carry out effective on-station research will address the problem. They have therefore not invested in either the development of national research systems or in the training of nationals on the scale necessary. Now that national research systems have been recognized to be a critical bottleneck, however, all donors, who often have conflicting ideas as to what research to conduct and how, have begun to focus on the systems, creating much competition and confusion in the African countries, especially given the limited resources they can bring to bear.

The implications of food surplus in the world must also be considered here in their effect on motivation to address policy problems in Africa. Food aid is relatively easily available to African governments, whose food import requirements are small. Therefore, they have not yet attached the degree of priority to the long-run development of their own science and technology capacity and to the improvement of their agricultural delivery systems to experience sustained growth in production and productivity. Although some are experimenting with policy reform, attempts at policy reform are by themselves unlikely to solve the problem. Even in encouraging policy reform, however, the donors have not yet begun to program their assistance to create the long-run policy planning capacity in African governments. Such emphasis on capacity building is needed, given the fact that African countries start with a poorer initial base.

The contrast between India and Africa shows that the nature and the severity of external shocks can make a difference in the extent to which policymakers in developing countries are willing to undertake reform. In India's case, however, both good planning and good luck played a much more important role than is generally acknowledged. India's own trained manpower and domestic economic planning ability could be harnessed in a period of crisis. The small number of donors helping India placed emphasis on strengthening India's policymaking, implementation and technological capacity.

These comparisons reinforce the point frequently made in the case of African agriculture, namely, that the sources of stagnation of rainfed agriculture are quite complex and will require a much longer time horizon to overcome. They will require a much more sustained effort than either donors or African governments are yet fully ready to undertake.

NOTES

1. These data are assembled in Arthur A. Goldsmith, "American Foreign Assistance and Agricultural Development in India," background paper prepared for the World Bank Development Strategy Division, 1985.

2. See Michael Lipton, *Why Poor People Stay Poor: Urban Bias in World Development.* Cambridge: Harvard University Press, 1977; T.W. Schultz, *Development and Change in Traditional Agriculture: Focus on South Asia.* East Lansing:Asian Studies Center, Michigan State University, 1968; and Paul Streeter and Michael Lipton, eds., *Crisis of Indian Planning.* London: Oxford University Press, 1968.

3. The discussion in the succeeding paragraphs draws from Uma Lele and Arthur A. Goldsmith, *Building Agricultural Research Capacity: India's Experience with the Rockefeller Foundation and its Significance for Africa,* DRD Discussion Paper #213, December 1986.

United States Agriculture in the Global Context

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United States agriculture is in a global context. On the order of half the farm land in the United States is used to produce for export. Without overseas markets, the amount of adjustment American agriculture would require to bring domestic supply and demand into balance is almost impossible to conceive. That adjustment would involve the movement out of agriculture of about half of the resources of American agricultural production. If comparative advantage was at work without overseas markets, the bulk of farmers would leave agriculture and well over half of all the land which is now in agriculture would convert to other uses. American farmers must think in a global context, must recognize that their future depends on export markets and must recognize where those export markets are. This hardly seemed a problem a decade ago, but it is very much a problem now.

Before I proceed, I would like to state a simple message and a broad thought. We should all be thankful for the bountiful harvests occurring in much of the world. We should be concerned that if we are complacent about those harvests, they will diminish in the future. We should be apprehensive that the extreme complexity of the task of using these bountiful harvests to banish hunger and to bring prosperity to those who produce them will turn us away from the policies needed to sustain and use that abundance.

I am grateful to Leonardo Paulino and J.S. Sarma for stimulating interaction on these important issues, David Chesser for developing much of the data, and especially to Tom Harrington for his efforts in developing data and drafting the paper.

The Current Situation

Today there appears to be an abundance and even a glut of food. In sharp contrast, a little more than a decade ago the World Food Conference was called to recommend immediate action to deal with scarcity and even famine in Asia and Africa. Global cereal stocks in the mid-1980s have been more than twice as large as in the mid-1970s. Real world cereal prices in 1985 were 30 percent lower than in 1981, compared to an almost twofold increase from 1972 to 1974. Real fertilizer prices have fallen to equal the lows of the late 1960s, after having more than quadrupled in real terms from 1971 to 1974. A lack of natural feedstock is now much less worrying than inadequate investment in fertilizer production. The focus of food shortage has switched from Asia to Africa.

In the early 1970s, not only was food scarce, but so were the inputs for producing it. If a low-income country had a crop failure, it was difficult for them to command the foreign exchange to import necessary food, food aid was greately diminished, and it was difficult to purchase fertilizer on the open market even if the countries had the necessary financial resources. That was an extremely difficult time for all food deficit countries and particularly the low-income ones.

Finally, many developing countries were diverted from long-term development efforts by overwhelming debt problems and the need for major adjustments in foreign exchange rates and their national budgets.[1]

In comparing the 1980s with the 1970s, it is worth making note of the switch in emphasis of food problems from Asia to Africa. In Asia in the late 1960s famine was widespread and the scarcity of food was acute. People like the Paddock brothers, in *Famine 1975,* were writing in favor of triage. The Paddock brothers argued that the food situation was so hopeless in Asia that close to a billion people should be written off as having no hope for survival. Although that idea was foolish even then, it is well to note how bad the situation looked at that time. Africa, however, seemed to be a continent abundant with land and with ample supplies of food.

The Green Revolution in Asia accelerated the rate of growth of food production considerably in the late 1960s and the 1970s. That, combined with the generally more favorable food situation in the world and growing incomes in many Asian countries—which allow them to increase food imports when in need—has switched the world food problem away from Asia. In Africa, however, per capita food production has been declining rapidly for a decade or two. Per capita consumption has also fallen. That has occurred in the midst of a miserable economic performance in most African countries that has resulted in acute food scarcity even in the face of the present global abundance.

Underlying Trends

Food production and consumption data for many developing countries are notoriously poor. Thus in examining the data and drawing conclusions about past trends and certainly for extrapolations into the future, one must be cautious. For some commodities, such as cassava in Africa, different sources show trends going in opposite directions, not just differences in magnitude. Thus we will be particularly careful with the root crop data, and we will be careful to deal only with large aggregates, which, one can hope, average out discrepancies in the data.

It is also worth adding that analysis of these trends is useful for getting an indication of the forces affecting supply and demand. Given that these forces tend to be stable and powerful, it gives us a basis for looking into the future. Despite the statistical difficulties, the policy conclusions which follow from the analysis are significant. They, of course, may lead inexorably to policy actions unacceptable to important interest groups. Thus, even analysis of past trends becomes a controversial matter. The facts of the global food situation are as contentious as the extrapolations.

As we discuss these underlying trends, we will see that the dynamic global food supply/demand balance links the interests of developed and developing countries and has important implications for foreign assistance, agricultural research policy, and the domestic agricultural policy of the United States.

For the period 1961-80, developing countries' cereal production grew at an annual rate of 2.9 percent per year; consumption grew at the considerably faster rate of 3.2 percent per year (table 1).[2] Hence, net annual cereal imports of the developing countries increased more than fourfold in 20 years from about 15 million tons to 64 million tons.[3] These data exclude the People's Republic of China because the extreme variability of production caused by major political events associated with the "Great Leap Forward" and the "Cultural Revolution" grossly distorts trends that include these periods.

Table 1
Trend Annual Growth Rates of Cereal Consumption and Production for Developing and Developed Countries 1961-80 and 1961-83

Country group	1961-80		1961-83	
	Consumption	Production	Consumption	Production
Developing	3.6	3.5	3.6	3.5
(excluding China)	(3.2)	(2.9)	(3.3)	(2.9)
Developed	2.5	3.1	2.2	2.8

SOURCE: FAO, "Production Yearbook Tape, 1984," and "Agricultural Supply Utilization Accounts Tapes, 1984" (Rome 1985).

Cereal imports to developing countries grew slowly in the 1960s and then accelerated sharply after 1972, with that accelerated growth showing no sign of decline through 1984 (table 2).[4] Developing countries increased their share of total world imports of cereals from a 1961-63 average of 36 percent to a 1981-83 average of 43 percent—an absolute increase of 315 percent (table 3). The developing countries represent the only cereal market capable of rapid growth.

Table 2
Growth Rates and Relative Shares in Cereal Trade
1961 to 1983

Country group	Average annual growth rate*			Relative shares		
	1961-83	1961-72 (percent)	1972-83	1961-65	1970-74 (percent)	1981-83
Imports						
Developing	6.0	3.0	8.1	36	35	43
Developed	4.6	4.0	3.3	64	65	57
Exports						
Developing	3.4	2.7	6.2	19	15	15
Developed	5.5	3.9	4.8	81	85	85

*Based on trended FAO data.

Table 3
Distribution of World Cereal Imports by Country Groupings
1961-63 and 1981-83

Country group	1961-63		1981-83	
	Million metric tons	Percent	Million metric tons	Percent
Developed countries	54.9	64	130.8	57
Developing countries	30.9	36	97.5	43
All countries	85.8	100	228.3	100

SOURCE: FAO, "Agricultural Supply Utilization Accounts Tape, 1984" (Rome 1985).

From 1961 to 1980, cereal production in the developed countries grew 3.1 percent per year. Consumption grew at a much slower pace, 2.5 percent per year, with the difference representing a rapidly growing exportable surplus.[5] Developed country imports and exports dropped sharply from 1981 to 1984, with a substantial recovery in 1985.[6]

The Future: Projections to 2000

Projections of past trends for food supply and demand, though an uncertain indicator of the future, have three features that recommend them: they smooth the effects of short-term influences such as weather; they illuminate the effects of cumulative forces; and they show potential changes in a country's position from net importer to net exporter and vice versa, arising from given supply and demand changes. Such projections are particularly revealing for food, for which underlying structural forces of supply and demand only change slowly.

A standard projection from 1980 to 2000 for developing countries, assuming that trends in output and income from the 1960s to 1980s continue, shows an increase in the shortfall (or imports) of staple food crops of 40 million tons. Actual net imports in 1984 were on the projected trend line.[7]

Growth in the demand for livestock products is an important source of growth in the demand for basic food staples. While in developing countries waste and by-products initially sustain livestock production, accelerated growth of livestock output quickly surpasses the inelastic supply of such feed. Further increments to production are made largely on concentrate feeds, particularly cereals. The projections cited above assume constant feeding rates in livestock production.

If, however, we project the trend growth of feed use during the base period and further assume market relationships for livestock products at constant relative prices, the production shortfall in developing countries increases by another 40 million tons.[8] It must be emphasized that this projection of feed use requires a return to the per capita income growth of the 1966-80 period. The debt and structural adjustment crises must be met and passed beyond.

Developing countries have been expanding livestock product imports rapidly. Since livestock production is generally labor intensive, it is logical for developing countries to displace projected imports with domestic production. Success in such an effort would, conservatively, add another 40 million tons to food crop imports.

These favorable circumstances in essence mean that developing countries would improve their development strategy and return to the growth rates of the 1960s and 1970s. If they did this, developing country imports would grow at a rate similar to or higher than in the past two decades.

Three caveats must be noted about such projections. First, one must take these numbers in aggregated form and not look at individual countries. That is because so many of the unpredictable events in the world benefit some countries and not others. For example, in the 1970s growth in most of the oil-producing countries surged ahead, it is said, at the expense of many oil-importing developing countries; perhaps the reverse will happen in the 1990s. Countries differ in their natural resource bases: Argentina and Thailand have very different ratios of people to agricultural production resources from Taiwan or Bangladesh. On all these matters, grouping countries helps us see central tendencies—at times we do want to see the forest and not the trees.

Second, and very important, when we look at food gaps and trade figures, we are looking at small residuals from large estimates of consumption and production—small differences in production and consumption data give large differences in "trade." It is rash indeed to predict trade volumes and their effects on global prices.

Third, we are poorly placed to judge the effects of pure science breakthroughs in biology on agricultural production. Keep in mind that while such breakthroughs add to demand as well as supply in developing countries, they add only to supply in developed countries.

Theory

Before drawing conclusions, it is useful to briefly outline the theory that lies behind the trends and relationships just presented, a theory that gives credibility to such projections. I abstract grossly for brevity.[9]

In developed countries, food demand is virtually satiated and hence does not increase with income. In contrast, food output grows continuously through research and various complementary institutions. Without export growth, the benefit of technological change can only be realized by undertaking the socially difficult task of rapidly withdrawing resources (land and people) from agriculture.

In sharp contrast, in developing countries, the rising incomes of low-income people, derived from employment growth, are converted by remarkably high demand elasticities into effective demand for food—60 to 80 percent of incremental incomes are so spent. Thus in developing countries, increased food supplies and increased employment are two sides of the same coin; one cannot proceed long without the other.

Furthermore, accelerated growth of food production can set in motion powerful multiplier forces on the growth of income and, especially, employment in other sectors. That, coupled with growth arising autonomously in the other sectors, results in the picture of fast growth in basic food staples production accompanied by even faster growth in consumption.

These relationships make reasonable the remarkable finding that from the early 1960s to the late 1970s, the 29 developing countries with the fastest growth rates in basic food staple production increased their imports of basic food staples by 360 percent in the same period.[10] This potential for developing countries to expand demand for food faster than even high rates of growth of food production needs to be understood and nurtured. It offers exciting prospects for the reduction of poverty and malnourishment.

Implications: Developed Countries

The credibility of projections for developed countries is reduced by the large year-to-year fluctuations in food production. However, a simple projection to the year 2000 of domestic use and production for the period 1961-80 shows an exportable surplus from developed countries more than double the largest projection for developing country net imports.[11] These estimates assume no diminution of growth rates for livestock feed inthe Soviet Bloc from the high rates of 1961-80. Such estimates confirm the need for a large reduction in developed country agricultural production.

These estimates are extraordinarily fragile. If, for example, the production growth rate in developed countries were to drop to equal rate of 1972-83 and consumption growth rates were maintained, then the developed countries would actually become net importers.[12] Unfortunately, while prediction of developed country exports is highly uncertain, it matters immensely to the choice of development strategy in developing countries.

Since the production trends in developed countries are very much subject to policy, it is well to keep in mind the following points.

First, developing countries as a group will prosper more if they do not face rapidly rising food prices driven by their own demand. Conversely, they will be harmed by intermittent dumping on international markets and the consequent unpredictable periods of sharply depressed prices.

Second, demand is much more responsive to price in developing countries than in developed countries, while supply is more responsive in developed countries than developing countries. Thus, rising global food prices foster surpluses in developed countries and reduce demand in developing countries, primarily through effects on the poor.

Third, however, the pace at which export surpluses are generated in developed countries now appears to be rapid enough to depress international prices severely, suggesting a need for stuctural adjustments in developed countries despite the rapidly growing Third World market.

Fourth, given the social costs in developed countries of drastically reduced food production and the potential to raise food demand in developing countries through food aid-based employment growth, it is logical to develop such programs on a much larger scale than at present.

Implications: Developing Country Exporters

There are now few developing country net exporters of cereals. Two countries, Argentina and Thailand, with their favorable land-to-person ratios, accounted for 68 percent of total developing country cereal exports in 1979-83 and will export considerably larger amounts by 2000.[13] There are probably one or two other developing countries with similar land resources and export potential but with unfavorable policies that hold back their agricultural potentials. These few countries are severely injured by food dumping by high-income countries.

It is important for American farmers to recognize that while their markets lie in developing countries, there are very few developing countries that have a potential to be major exporters. They have in the past supplied about a quarter of the increment to developing country commercial food imports; three-quarters has been left for the developed countries, including the United States.

In sharp contrast to Thailand and Argentina, the bulk of the countries projected to export food in the future are poor countries with high-population pressure. That is a quite different story.

In projections to 2000, countries with per capita incomes less than $500, strikingly, provide 83 percent of developing country net exports of major staple foods other than those of Thailand and Argentina. In particular, four countries—China, India, Indonesia, and Pakistan—account for 71 percent of projected developing country net exports, excluding Argentina and Thailand (table 4).[14]

Table 4
Relative Shares of Projected Developing Country Net Production Surpluses by Level of Per Capita GNP (1980), 2000

Projected net surplus countries by level of per capita GNP 1980	Net production surplus 2000 (Million metric tons)	Net production surplus 2000 (Percent)	Percentage of total production 2000 (Percent)
Less than $500	50.1	43	61
(China, India, Indonesia, Pakistan)	(42.9)	(37)	(58)
Greater than $500	66.3	57	11
(Argentina, Thailand)	(56.2)	(48)	(6)

SOURCE: Data set used in preparing IFPRI Research Report 52, *Food Trends in the Third World: Past Trends and Projections to 2000*. Projections based on FAO "Production" and "Agricultural Supply Utilization Accounts" tapes according to methodology described in Appendix 1 of Research Report.

Exports of food clearly represent a failure in employment generation and poverty alleviation for countries with per capita incomes less than $500. Half or more of their populations are deficient in food intake. The countries in the low-income group projected to become exporters tend to be large and populous, to have a substantial percentage of their total GNP in nonagricultural sectors, but a large percentage of total labor force in agriculture—the former typically twice the latter.[15] Their low per capita GNPs are, in general, increasing slowly. These characteristics suggest that they have capital-intensive investment policies causing low growth in employment, to the detriment of their low-income people. A change in investment strategy would foster faster and more equitable growth, accelerate the food production growth rate and change these countries from food exporters to food importers.

We now see an interesting question. Is the tendency of some low-income countries with large, hungry populations to export a result of bad policy or is it a passing structural problem? One could argue that since the problem is concentrated in the under $500 per capita income countries, and seems to resolve itself when income exceeds that level, that we should just wait. But there are difficulties in getting a country well enough organized so that the small and medium scale service and manufacturing sectors, which are so employment intensive, can expand rapidly. The argument would run that as the development process proceeds, the infrastructure is built, the trained personnel are developed, and the institutional structures necessary for rapid growth in employment are created. The lower-income countries simply have not yet finished these complex tasks, but they will.

Alternatively, one might argue that countries such as Indonesia, India, Pakistan and the People's Republic of China, the principal countries in this category projected to have large exports despite widespread hunger, have simply followed wrong development policies, that they have concentrated their capital on a few, large-scale, highly capital-intensive industries that create little employment. This leaves little capital to spread over most of their population, meaning that activities that are employment-intensive are starved for capital. In this argument, a change in the policies these countries have for prices, the allocation of capital, and public sector investment would bring about much more rapid growth in employment and the demand for food. Those countries would then cease to be exporters and would move on to the import market as do so many other developing countries with a similar economic situation. I will return to this issue later under the question of policy for foreign assistance and for American agriculture.

Implications: Developing Country Importers

It is notable that, virtually without exception, developing countries with per capita incomes greater than $500 are able to generate demand for food more rapidly than domestic production growth. Developing country importers with per capita incomes less than $500 also manage to increase employment and hence effective demand more rapidly than production. Of course the least developed countries with the lowest incomes simply have low growth rates in food production. They are able to use foreign assistance and food aid to keep consumption somewhat higher than would otherwise be possible.

The number one policy need for net food importing countries is an international environment in which food supplies are reliable. If they are to expand employment more rapidly than food production, they must believe, first, that the shortfalls generated by these divergent trends can be met without steadily rising prices. That means there must be a reliable international market. Second, and perhaps even more important, they need to be protected from radical fluctuations in domestic and international supplies. For the latter, one needs a source of international finance such as a well-operating International Monetary Fund cereal facility. Whether enlarged stocks are needed as well is a moot point.

In order for employment growth to increase demand for food more rapidly than domestic supply, there must be wide participation in the development process. This, in turn, requires a rural infrastructure that brings most people into close contact with the improved markets and technology necessary for the modernization of agriculture. There is also a need for the development of employment linkages between agriculture and the rest of the economy so that growing agricultural incomes will produce expenditure patterns and responses to those patterns favorable to the growth of rural industry and employment. Agricultural growth through cost-decreasing technological change is the basic engine for such growth.

A Note on Foreign Assistance Policy

Foreign assistance policies that support a strategy of growth oriented toward increasing agricultural production and employment are favorable both to growth and to poverty alleviation in developing countries and to increased markets for food exporters. What are the broad policy outlines of such a strategy?

First and foremost is investment in agricultural research and its supprt services to start the engine of growth. Agriculture is a difficult sector to move because of the constraints on the land area. Thus the growth of agricultural production is subject to rapidly diminishing returns and hence increasing cost unless agricultural research is performed, as has been so dramatically successful in the United States, effectively so as to come up with new technologies that increase yields per acre. Those same technologies, which are essential in land-limited Asia, also raise labor productivity under the conditions in Africa where labor productivity is a more serious problem than land productivity.

Second is assistance to growth of infrastructure to ensure breadth of participation in growth. In a world of food surpluses, hungry people, and inadequate rural employment, investment in infrastructure offers immense potential for the effective use of food aid, particularly in the low-income countries. It is puzzling that hunger and lack of labor for building infrastructure, can coexist with huge food surpluses.

Third is increasing food security nationally and internationally. That is needed because a strategy relying on food and employment growth is terribly vulnerable to the effects of normal fluctuations in food production.

Behind all these processes is a rapid expansion of trained people—a high-employment strategy of growth is accompanied by extraordinarily rapid growth in demand for educated people at all levels. Foreign assistance is most effective when helping meet that demand.

Agricultural Research Policy

I want to comment specifically on agricultural research policy for developing countries in the current global food context because of the central role of research to agricultural progress. The onset of the Green Revolution in Asia was very much a product of American foreign assistance, in part from the foundations, particularly the Rockefeller Foundation and the Ford Foundation, and in part from U.S. government foreign assistance. Assistance to agricultural research development in Asia, and now in Africa, continues to be an important element of foreign assistance.

At the same time that agricultural research forms such an important element of foreign assistance, we find farmers in the United States who are concerned at loss of export markets, wondering whether helping developing countries to do agricultural research that brings about increased production is going to provide competition in the domestic markets of those countries and even from exports. As we can see from a few countries such as Argentina and Thailand, and looking into the future, even more from some of the poorer countries, that is a legitimate concern. I have tried to emphasize how foreign assistance may be constructive in helping demand to increase more rapidly than the supply of food in the low-income countries characterized by great poverty, shortage of food, and malnutrition.

The new environment of apparent global abundance of food brings somewhat differing requirements for food production research.

First, there must be an even greater emphasis than in the past on reducing the costs of production and hence raising incomes. In Asia, cost reductions occur by raising yields per acre. In Africa, the problem is more complex. Labor productivity is the greatest limitation to production in Africa. We can already substantiate that, in general, the appropriate way to raise labor productivity in Africa is through yield-increasing technology.

In Asia, since the International Rice Research Institute's pioneering work, which generated the variety IR8, we have not seen a major increase in rice yield potential or reduction in the cost of producing rise. In fact, the real cost of production has been slowly rising over the past decade. Recent efforts have been dedicated largely to maintaining the yields produced by IR8 and widening the benefits of such varieties by increasing their adaptability and improving their resistance to diseases and pests. In this context, one can truly talk about saturation of the rice area with these high-yielding varieties. How will the growth rates of the recent past be maintained into the next decade or so? That is a serious problem in Asia. Our impression of food abundance will disappear within a decade or two without another research breakthrough.

Second, with a more bountiful food supply in the world, we have the opportunity to take more meaningful steps towards sustainable growth in agriculture. On the one hand, we must increasingly shift higher-yielding, more productive farming systems into environments whose ecosystems can sustain such increased intensity. That should allow a gradual increase in the proportion of population in areas more able to sustain it, while reducing population pressures in areas that cannot sustain arable agriculture. We must ask ourselves what the implications are of this to two related research questions: (1) Under what circumstances and by what mechanisms can we use the increased abundance of food in the world to reduce population pressures more rapidly in areas that cannot support arable agriculture? (2) Should that then push our research resources more towards the perennial grasses and tree crops that can be sustained in such areas?

Third, when the abundance of food increases, we must maximize the linkages between agricultural growth and employment growth in nonagricultural sectors. That too requires research. Increasingly, lack of effective demand for food is proving to be a constraint for developing countries with per capita incomes less than $500, in spite of progress in agricultural production. We have done a good job of documenting the existence of linkages between agricultural growth and employment in other sectors, but we have not gone far in producing the policy prescriptions for maximizing the size of those linkages.

Fourth, where food is more abundant, we can turn more vigorously to increasing employment by developing smallholder livestock production. Here we face elastic demand for the product and hence a substantial increase in demand from a small decline in prices. There are, however, clear technical problems, not only in production but also in marketing. Because of the inelasticity of waste and by-product feed supplies, research must have a twofold emphasis on increasing the productivity of grasslands and improving our knowledge about the productive use of concentrate feeds. Any enhancement of livestock production will also help to solve the difficult problem of inferior grains, such as millets and sorghums, and even maize. They are well-suited to large areas and there are good possibilities for increasing their yields. Yet the demand for them is highly inelastic except as livestock feed.

Fifth, with an increasing abundance of food, we need to focus our attention more on the problems of the poorest countries and the poorest people within those countries. However, these two sets of problems call for different treatment.

There undoubtedly needs to be an emphasis on the better areas within the poorest countries in order to increase the returns to investment in agriculture and to generate the funds for tackling the much more difficult problems of the more backward areas.

We must differentiate clearly between short-term needs to mitigate the problems of the poorest people in the poorest regions, and longer-term adjustments that can be made as population densities in those areas are gradually reduced through more intensive and sustainable development elsewhere.

Conclusion

Two things seem clear from the foregoing analysis, the first somewhat more than the second. The future of American agriculture lies with the development of developing countries. They must raise their incomes, not just generally but among the lower-income half of their population specifically, so that those people have the purchasing power to increase their expenditures on food and to improve their diets. Thus it is in the interest of American agriculture to see development move quickly in developing countries. Because those countries are largely agricultural, that can only happen by developing their agriculture. Because they have either a shortage of land or extremely low labor productivity, incomes in agriculture can only be increased through research-based technological advance. Thus we find the anomalous situation that it is good for American agriculture to vigorously support agricultural research in developing countries so that they can increase the productivity of their agriculture. That proves not to be an anomaly because, as incomes in those countries rise, people spend a high percentage of their increased income on food. That is in sharp contrast to the developed countries where rising incomes of even quite low-income people essentially do not increase demand for food.

The second conclusion is that, at their rate of growth of food production over the last two decades, the developed countries will produce far more than is necessary to meet the import needs of developing countries. Thus there will undoubtedly have to be structural adjustment in the agricultures of the developed countries. This is not just the United States and Canada, but also Western Europe. That structural adjustment need not necessarily come from reduced prices, but our experience is that without lower prices the fiscal cost to governments is far more than they are willing to bear for long, although one cannot help but note that the willingness to bear high fiscal costs to support agriculture seems to be quite great. In both Western Europe and the United States, we are shouldering subsidies to agriculture that are multiples of what was thought the largest possible a decade or so ago.

If we put the first point and the second point together, we have a caveat: that if we expect developing countries to emphasize both increasing their demand for food and increasing production of food in their countries, we are asking them to throw themselves open to the vagaries of weather to a much larger extent than with alternative strategies. If they are to do that, they will want to believe and will want to know that food security is assured to them. That can be done through the financing facilities of the International Monetary Fund so that poor people in poor countries can bid food away from livestock during periods of scarcity. It also means that the developed countries, while making adjustments to their agricultures, must be careful not to go too far and bring back the food scarcities of the 1970s.

Let us hope that the present abundance of food is not an illusion or a quickly passing aberration. Let us recognize abundance for the blessing it is. Let us respond by raising incomes in developing countries with new, cost-effective food production technology; by using food surpluses to back labor-intensive investment in the infrastructure that so broadens participation in growth; by providing food security measures that reduce the risks governments face; by caring about poverty and acting to reduce it; and most important, by learning now how to bring the lower-income countries to the stage of development where effective demand for food outruns effective agricultural development policies.

NOTES

1. As cited in "Commentary: The Changing Global Food Scene—Opportunities for Development and Poverty Alleviation," *IFPRI Report*, Vol. 8 (3) (Washington, D.C.: International Food Policy Research Institute, October 1986).

2. Food and Agriculture Organization of the United Nations, "Production Yearbook Tape, 1984" and "Agricultural Supply Utilization Accounts Tape, 1984" (Rome: FAO, 1985).

3. Food and Agriculture Organization of the United Nations, "Agricultural Supply Utilization Accounts Tape, 1984" (Rome: FAO, 1985). "Developing Countries" includes China, the twenty-year period referring to 1961-65 to 1979-83 averages of net annual cereal imports.

4. Food and Agriculture Organization of the United Nations, "Agricultural Supply Utilization Accounts Tape, 1984" (Rome: FAO, 1985). The annual growth rate of cereal imports to developing countries changed from 3.0 percent (1961-72) to 8.1 percent (1972-83).

5. Food and Agriculture Organization of the United Nations, "Production Yearbook Tape, 1984" and "Agricultural Supply Utilization Accounts Tape, 1984" (Rome: FAO, 1985).

6. Food and Agriculture Organization of the United Nations, "Agricultural Supply Utilization Accounts Tape, 1984" (Rome: FAO, 1985).

7. As cited in L.A. Paulino, *Food in the Third World: Past Trends and Projections to 2000*, Research Report 52 (Washington, D.C.: International Food Policy Research Institute, 1986), Table 12, p. 42. The projection excludes China, and assumes trend growth in production (1961-80) and consumption (based on per capita income growth trends 1966-80 and FAO elasticities for food and meat consumption).

8. Paulino, *Food in the Third World*, Table 15, p. 62.

9. This argument is developed fully in John W. Mellor and B.F. Johnston, "The World Food Equation: Interrelations Among Development, Employment, and Food Consumption," *Journal of Economic Literature*, 22 (June 1984).

10. Twenty-nine rapid agricultural growth developing countries increased their food imports from 2.37 (1966-70) to 8.57 (1976-80) million metric tons, an increase of almost fourfold.

11. Projections were done for developed countries as a group and compared production and total domestic use by a methodology similar to but simpler than that of Paulino—i.e., based on not income elasticities of demand but trend comsumption patterns. Feed was projected on a trend; food was projected to remain constant at 1966-80 per capita consumption levels times the expected increased population.

Different base years chosen for production yielded varied outcomes, ranging from a high net surplus of production of 400 million metric tons (1961-80) production trend to a low net deficit of production of 57 million metric tons (1972-83) production trend. When developed countries were projected by regional groupings, the net surplus was 136 million metric tons, reflecting a high rate of feed consumption in Eastern European countries.

12. See footnote 11.

13. Food and Agriculture Organization of the United Nations, "Production Yearbook Tape, 1984," and "Agricultural Supply Utilization Accounts Tape, 1984;; (Rome: FAO, 1985), and projections in Paulino, Research Report 52. Argentina is a net exporter of 17 million metric tons and Thailand of 6 million metric tons (1979-83 averages), and they are projected to have net surpluses of 26 and 30 million metric tons respectively, in 2000, or 50 percent of the total projected net surplus.

14. From data set on individual countries used in Paulina, *Food in the Third World*. Assumptions of projections are the same as described in footnote 7.

15. Data from World Bank, *World Tables*, Volumes 1 and 2 (1983).

Additional Readings and References

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Mellor, John W. *The New Economics of Growth: A Strategy for India and the Developing World.* A Twentieth Century Fund Study. Ithaca, NY: Cornell University Press (1976).

Mellor, John W., Christopher L. Delgado, Malcolm J. Blackie (eds.). *Accelerating Food Production Growth in Sub-Saharan Africa.* Baltimore, MD: The Johns Hopkins University Press (1987).

Mellor, John W. and Gunvant M. Desai (eds.). *Agricultural Change and Rural Poverty: Variations on a Theme by Dharm Narain.* Baltimore, MD: The Johns Hopkins University Press (1985).

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Foreign Assistance and American Agriculture

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A major policy confrontation is brewing over United States technical assistance to agricultural development efforts in developing countries. The longer U.S. farming remains in a financial depression due to competitive pressures on its agricultural exports, the more vehement is the criticism that U.S. bilateral and multilateral aid to developing countries, especially to their agricultural sectors, is stabbing American farmers inthe back. Directors of international agricultural programs in the nation's land grant universities feel this heat most directly, as their budgets are subject to review by state legislatures. Most of the faculty involved in these programs also have speaking and extension responsibilities that put them in day-to-day contact with farmers. United States Department of Agriculture and USAID officials are grilled on this topic during their testimony to Congress.

The response to these pressures has been a careful and documented appeal to the empirical record based on a growing volume of academic analysis of the relationship between agricultural growth in developing countries and trends in agricultural imports, especially from the United States. There now seems to be a rough consensus in the agricultural development profession that a positive connection exists between these two dimensions of the development process. The best summary of this view is from Earl Kellogg, an agricultural economist who serves as associate director of the International Agriculture Program for the University of Illinois, in a state that feels very keenly the competitive pressures on exports:

> Developing countries continue to be the best potential growth markets for U.S. agricultural exports. To realize this poten-

> tial, they must achieve economic growth that results in increased per capita incomes and foreign exchange availability. Because of the size and economic importance of the agricultural sector in developing countries, it must contribute to this economic growth. In addition, developing countries must be able to export products in which they have a comparative advantage. To accomplish this growth in income and exports will require that developing countries obtain capital and technical assistance for agriculture and other economic sectors. If growth and development are achieved, developing countries can continue to be important customers for U.S. agricultural exports.
>
> For a number of reasons, then, improving agricultural and food production in developing countries is important to U.S. interests. These efforts benefit people living in poverty, improve the chances for world peace and stability and also contribute to the long-term prosperity of American agriculture.[1]

Most of us in the economic development profession hope that this view—that development assistance benefits both recipient and donor—is true. The historical record is reassuring. A study of the 1961 to 1976 period by Bachman and Paulino for the International Food Policy Research Institute (IFPRI) noted a positive relationship between agricultural production and staple food imports.

> The data suggest that staple food exporters have little cause to worry about the rapid growth of food production in the developing countries. Staple food imports in the rapid-growth countries increased much faster than exports, and, consequently, net imports continued to grow. Although the increases in food production in the study countries are impressive, it is evident that in most of these countries food production growth rates need to be maintained or further augmented to meet the increasing demand for staple foods.
>
> The expansion of both staple food exports and imports reflects on one hand the increased production capacity in particular crops in these countries and, on the other, the rapidly increasing demand generated by population growth and rising income levels. Income-induced increases in demand appear to arise from the growing demands for a greater variety of foods as consumption patterns change. Data from a number of rapid-growth countries indicate that part of the

> increased demand for staple foods arose from the expanding use of staple foods for conversion into livestock and poultry products.[2]

Kellogg cites analysis carried out at USDA that also supports this hypothesis.[3] Lee and Shane present Malaysia as an example of a country that is becoming a consistent and growing importer of U.S. agricultural commodities, especially feedstuffs, while rapidly developing both domestic and export-oriented agriculture.[4] A masters thesis at the University of Illinois conducted statistical analysis of 77 countries and found that in "no estimated equation were results obtained that showed a negative coefficient significantly different from zero for the correlation between per capita agricultural production in developing countries and their per capita imports of agricultural products."[5] Case study analysis of Brazil and South Korea as rapidly-growing countries and of Sierra Leone as a slowly-growing country further substantiated these statistical results.[6]

Thomas Morrison of the IMF Research Department has investigated the long-term and short-term factors affecting cereal imports in 1979/80. On the basis of a regression model for 48 countries which incorporated such long-run factors as GNP per capita, population density on arable land, average annual cereals production per capita (for the years 1977-79), and share of population living in urban areas, as well as short-run factors such as cereal production in 1979 as a percentage of the average, food aid (cereals) per capita, and gross international reserves available at the end of January 1979, relative to the average for the 1977-78 period, Morrison concluded as follows:

> Of the long-term determinants, level of economic development is the most significant in explaining cereal imports. The coefficient . . . is positive and significant at the 99 percent confidence level. This result is consistent with the hypothesis that level of economic development, through its relation to consumption demand . . . positively influences per capita cereal imports. The urbanization variable . . . without the GNP variable, has the expected positive coefficient, but the coefficient is not significant.
>
> Of the variables indicating domestic production capacity, only population density is significant. The coefficient is

> positive and significant at the 95 percent confidence level. . . . This variable, indicating population pressure on arable land, is the most reliable variable representing total domestic food production capacity.
>
> Cereal production per capita [average] has the expected negative coefficient, but is not significant. One reason why the coefficient is not significant is probably . . . that in many countries non-cereal crops represent significant shares of total food production.
>
> . . . The regression equations explained between 41 and 82 percent of the variation in per capita cereal imports across countries. Since government policies can have a significant influence on the level of cereal imports regardless of country characteristics and circumstances, one cannot expect such regression equations to have greater explanatory power. The fact that the equations have as much explanatory power as they do probably reflects the strong influence the country characteristics and circumstances have on government policies toward cereal imports.
>
> . . . The empirical results yield certain implications for the future of cereal imports by developing countries. It appears that the rapid growth of cereal imports by developing countries during the 1970s, particularly by the middle-income countries, will continue to the extent that these countries experience economic growth and pass into higher stages of economic development. Although population growth in the developing countries has declined from its peak of about 2.4 percent in the mid-1960s to about 2.2 percent currently, increasing population pressure on arable land will continue to be a significant factor affecting cereal imports in the foreseeable future. While food aid as a share of the cereal imports of developing countries has declined considerably over the 1970s, it will continue perhaps in a more limited way to provide cereals to those who could otherwise not afford them. Thus, the same factors that caused the rapid growth of cereal imports by the developing countries during the 1970s will continue to exert their influence in the 1980s.[7]

This line of argument is reasonable and comforting, but it is now demonstrably wrong for the 1980s. Why? The world debt crisis, the overvalued U.S. dollar, and U.S. farm policy are usually cited as reasons why exports of U.S. agricultural products to the developing countries have not grown since 1980. Kellogg, for example, drawing on the work at ERS by Longmire and Mory on exchange rate problems and by Shane and Stallings on the debt crisis, offers the following summary and observations:

> Although agricultural exports to developing countries have increased in the past several years, total U.S. agricultural exports have recently decreased from $43.8 billion in 1981 to $38.0 billion in 1984. There are three major reasons why this has happened.
>
> (1) The exchange rate of foreign currencies for U.S. dollars has increased. For example, it now takes 32 percent more German marks to buy one U.S. dollar's worth of U.S. goods than in 1981. A recent USDA study [Longmire and Mory] concluded that the stronger dollar cost the United States about $6 billion in lost farm exports over the two-year period 1981-83.
>
> (2) Some U.S. domestic agricultural policies tend to result in U.S. agricultural commodities being priced above world prices. This is obviously not good policy if one wants to encourage agricultural exports in a competitive world economy.
>
> (3) Total world agricultural trade has decreased since 1980 because of reduced economic growth in many countries and increased indebtedness of many developing countries. Shane and Stallings have estimated that the debt problem alone has lead to a loss in potential export sales to developing countries of up to 20 percent.
>
> None of these major reasons for declining U.S. agricultural exports has to do with increasing agricultural production in developing countries which is one of the objectives of U.S. universities and AID collaboration. From 1981 to 1984, developing country per capita agricultural production has essentially remained constant. Therefore, in the aggregate, increases in agricultural production within developing countries has not caused the decline in U.S. agricultural exports since 1981.[8]

This paper argues that all of these factors—the overvalued dollar, U.S. agricultural policy, and the mounting debt in developing countries—are connected and in turn are related to changing agricultural production in developing countries. Although a focus on any specific factor results in a positive relationship between U.S. assistance for agricultural development and subsequent value of U.S. farm exports, the picture is not so positive when all the factors are considered together. In other worlds, a global general equilibrium perspective has different conclusions from those of a partial equilibrium one and has important implications for the role and impact of U.S. foreign assistance. The ultimate conclusions in this paper remain positive, but they contain potentially unhappy messages for American agriculture and the need for it to adjust to new competitive pressures in world markets.

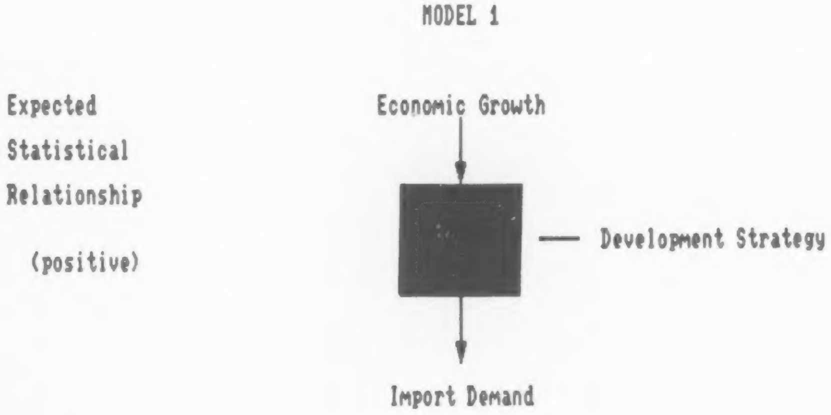
Explaining Import Demand for Grain

Why do countries import grain? To ask the question in such a bald way raises several possibilities other than trade patterns determined by short-run costs as reflected in the comparative advantage of trading partners. Recent emphasis on the food price dilemma faced by many developing countries suggests that grain imports might equally be treated as a policy instrument of governments attempting to reach an implicit or explicit set of objectives for their food sectors. These objectives can range from maintaining a price level (frequently ''low'') for a preferred foodgrain, assuring price stability, providing ''control'' over foodgrain markets through a government food agency, provisioning a livestock-feeding industry that produces meat for urban consumers, or even gaining the benefits of free trade.[9]

If the volume of grain imports is determined simultaneously with other important government policy actions, models designed to predict import levels must come to grips with the basic dynamics of each country's political economy. In those countries where foodgrain prices are an important ingredient in those dynamics, as they are in most countries of the world, a complex relationship exists among microeconomic demand patterns, macroeconomic policies, including basic foodgrain prices, and conditions in the world market for food and feedgrains. It is as wrong to think that grain imports are determined by relative costs and comparative advantage as it is that they are determined solely by "political decisions." Each factor influences the other, primarily through macroeconomic and budgetary forces. Hence, it is necessary to model international grain trading activities in a macro food policy framework.

Figure 1 shows the first of four different levels of detail in specifying such a model. Few would quarrel with the basic relationship specified in Model 1, which says simply that a country's import level is functionally related, through some "black box" of causal mechanisms, to its rate of economic growth. What is in the black box is, of course, crucial. The figure shows that the primary exogenous factor influencing the contents of the black box is a country's development strategy, especially whether an import-substitution or export-promotion strategy is being followed. Much evidence points to a significant influence of this strategic choice on the rate of economic growth itself, not just on its import intensity. This reverse connection between development strategy and economic growth will be incorporated in Model 4 where feedback mechanisms are considered. Obviously, other factors such as a country's size, its natural resource endowment, and so on also influence the relationship shown in Model 1.

Figure 1
Relationship Between Economic Growth and Imports



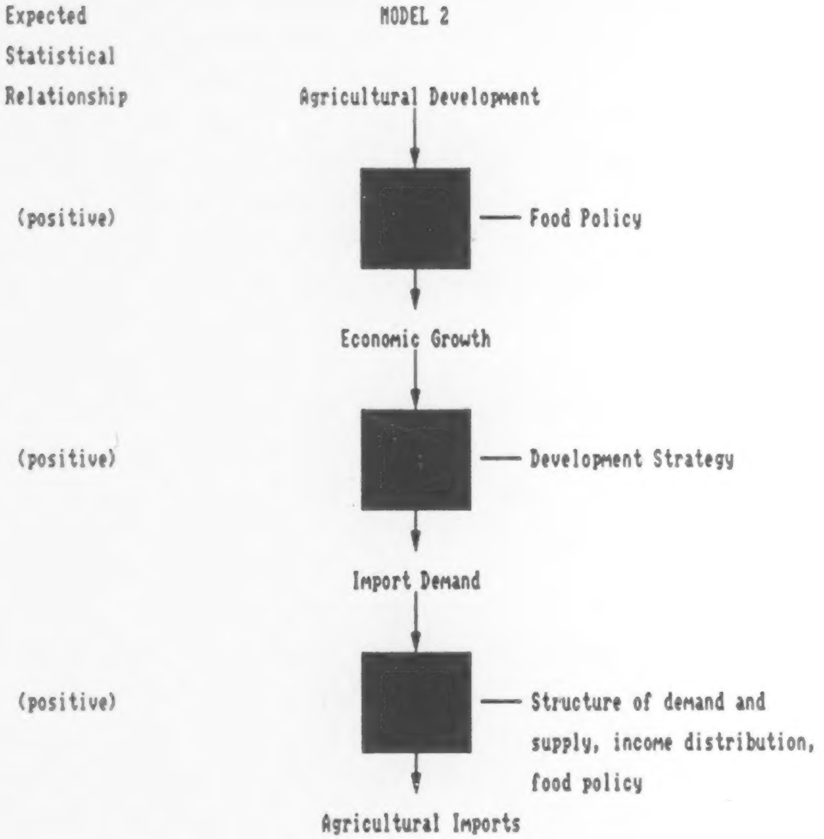
Although Model 1 says nothing at all about demand for agricultural imports from the United States, its trade balance is strongly influenced by the connections in Model 1. In fact, one of the arguments here is that, from the point of view of promoting U.S. exports, far more is at stake in the overall growth process reflected in Model 1 than in agricultural imports per se.

Agricultural imports are the focus of Models 2 and 3. Figure 2 presents a rough summary of the structural relationships posited implicitly or explicitly in the work cited by Kellogg and summarized in a recent report from the Curry Foundation, authored by Paarlberg.[10] The chain of causation is still fairly simple. Agricultural development, including rising staple food production per capita, positively influences the overall economic growth process through another black box mechanism. This growth translates into import demand through the same factors as in Model 1. Overall import demand leads to growing demand for agricultural imports, again through a set of complex causal relationships contained in a black box. In Model 2 the black box connecting agricultural development with overall economic growth is mediated by a country's food policy.[11] The mechanisms that connect overall level of imports with agricultural imports includes a system of supply and demand relationships for individual commodities as well as the influences of income distribution, urbanization, other demographic factors, and changing tastes. As stressed above, these mechanisms also include the set of food policy objectives, instruments, and interventions.

The expected sign of the statistical relationship between factors connected by black boxes is also shown in figure 2. Normally, each of the three relationships should be positive. Agricultural development leads to economic growth; economic growth leads to larger import demand; and larger overall import demand also leads to larger agricultural imports. The last relationship is the least certain in terms of economic logic and rests primarily on empirical evidence. Since the relationship between rapid income growth and food consumption provides a key piece of that evidence, a review of this nexus is a major part of this paper. Whatever the historical record, however, it is easy to postulate mechanisms that would lead to reduced agricultural imports even in the face of economic growth and rising nonagricultural imports.

Model 2 provides a rough vehicle for understanding the positive relationship that exists in the historical record between a country's agricultural development and its resulting agricultural imports. Each of the black boxes, however, contains important economic and political relationships which are subject to change compared with the historical record. In addition, Model 2 is incomplete in terms of explaining the "stabbed in the back" phenomenon because the role of technical assistance is not yet connected to agricultural development in developing countries, nor are agricultural imports into a particular country translated into the value of U.S. agricultural exports.

Figure 2
Relationship Between Agricultural Development and Agricultural Imports


Expected
Statistical
Relationship
MODEL 2
Agricultural Development
(positive)
Food Policy
Economic Growth
(positive)
Development Strategy
Import Demand
(positive)
Structure of demand and
supply, income distribution,
food policy
Agricultural Imports

Model 3 attempts to specify these additional relationships. Great controversy exists over the efficacy of technical assistance in helping low-income countries develop their agricultural sectors. Some would argue that the record is mostly negative; inappropriate technologies and commodities are stressed at the expense of village-level knowledge and foods of the poor.[12] At the other end of the spectrum is a ''science solves all food problems'' approach which sees a strong positive link between foreign assistance and agricultural development.[13] The black box connecting these two components of Model 3 reflects these controversies by linking technical assistance and agricultural development through the choice of an aid strategy. Perhaps the critical strategic choice is whether the aid focuses on project or policy assistance, a topic which is now receiving much attention in the donor community, with results that are beginning to show in world markets.

Model 3 shows two additional components relative to the simple structure of Model 2. A connection between a country's agricultural imports and the volume of U.S. agricultural exports is mediated by factors determining the competitiveness of U.S. commodities in international markets, especially exchange rates and domestic pricing policies, as well as by market development efforts by the United States, including the role of the PL-480 program. But the United States is concerned with not only the volume of agricultural exports but their value as well. To connect volume with value, it is necessary to determine the price received for the exported commodity. This connection is shown in Model 3 by the black box that contains the mechanisms of price formation in international commodity markets. This particular black box contains many of the global general equilibrium mechanisms that provide cause for concern that the historical record of the 1960s and 1970s will not play out so nicely for American farmers in the 1980s and 1990s.

Just as in Model 2, all of the expected statistical relationships contained in the black boxes in Model 3 are positive in sign. Considerable debate exists, however, over the two relationships at the bottom. There is no doubt that the total volume of U.S. grain exports, for example, is positively related to the volume of world trade in grain. But figure 4 shows that the structure of that relationship depends critically on the

Figure 3
Relationship Between Technical Assistance and the Value of United States Agricultural Exports

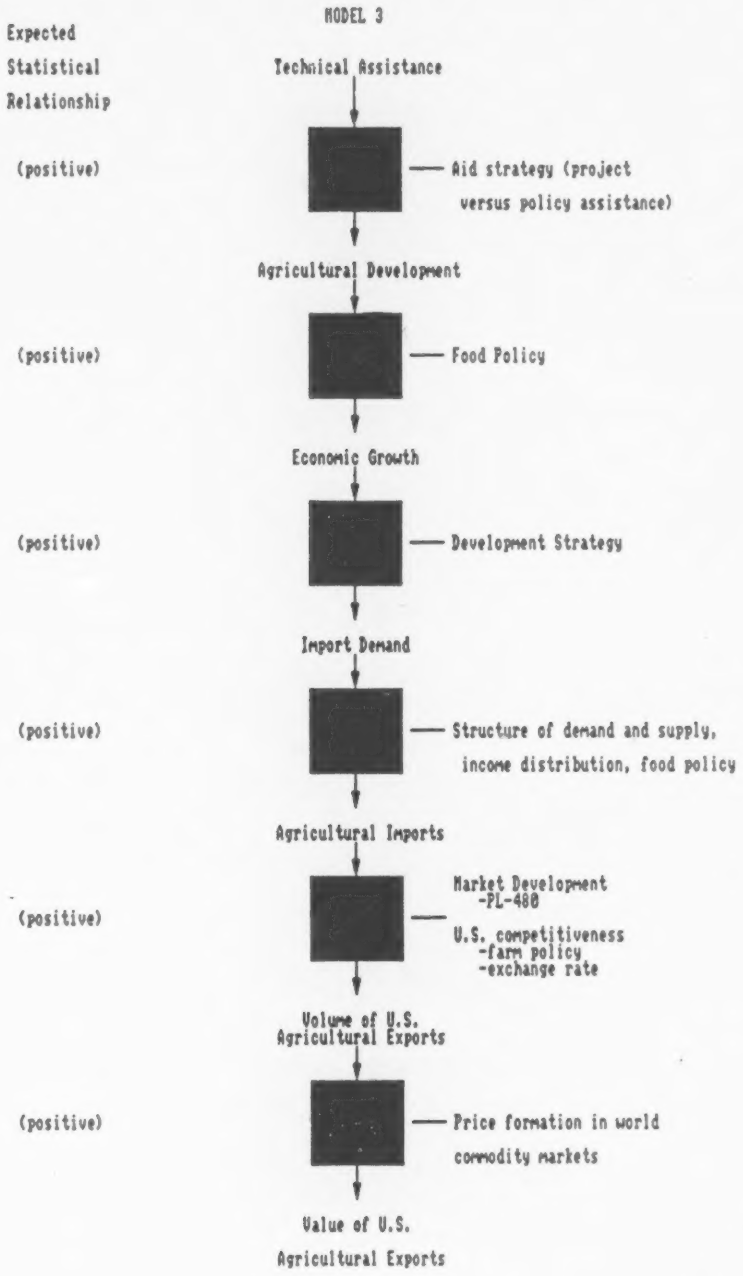
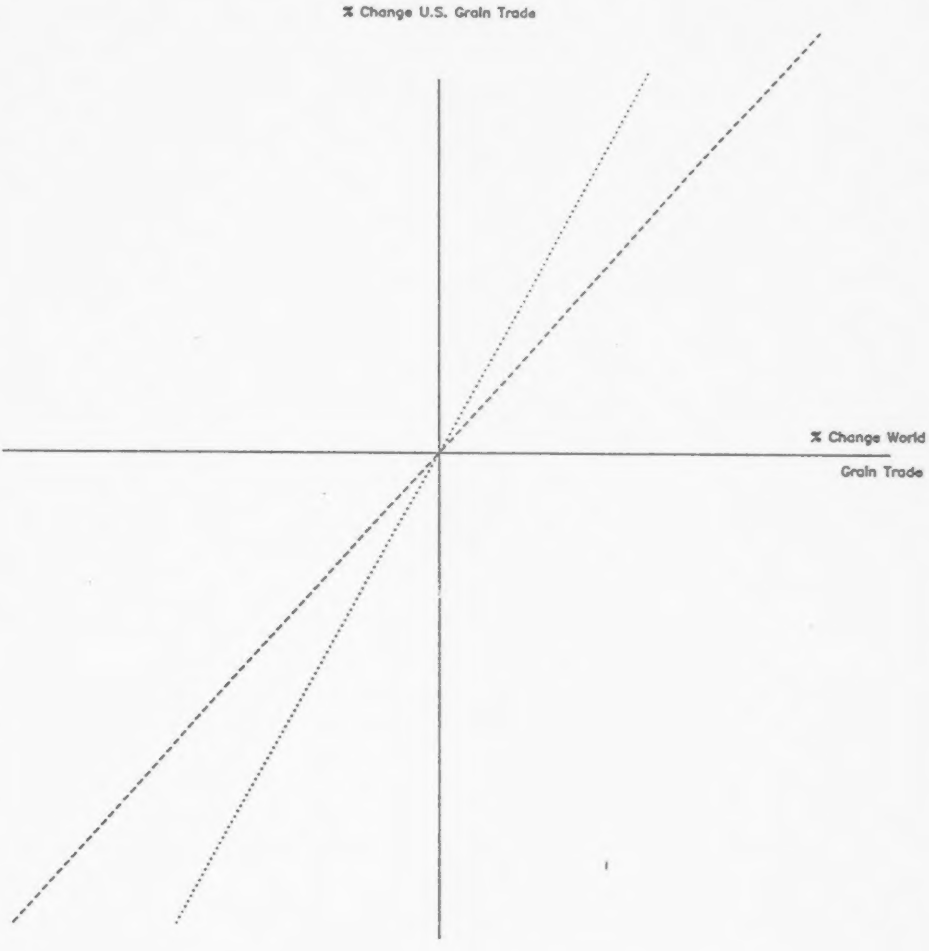

MODEL 3
Expected
Statistical
Relationship
Technical Assistance
(positive)
Aid strategy (project
versus policy assistance)
Agricultural Development
(positive)
Food Policy
Economic Growth
(positive)
Development Strategy
Import Demand
(positive)
Structure of demand and supply,
income distribution, food policy
Agricultural Imports
(positive)
Market Development
-PL-480
U.S. competitiveness
-farm policy
-exchange rate
Volume of U.S.
Agricultural Exports
(positive)
Price formation in world
commodity markets
Value of U.S.
Agricultural Exports

Figure 4
Relationship Between Percentage Change in World Grain Trade and Percentage Change in United States Grain Exports



Expected Relationship, U.S. Supplier of Last Resort

Statistical Relationship:

% change in U.S. grain trade = −0.0311 + 1.861 x % change in world grain trade

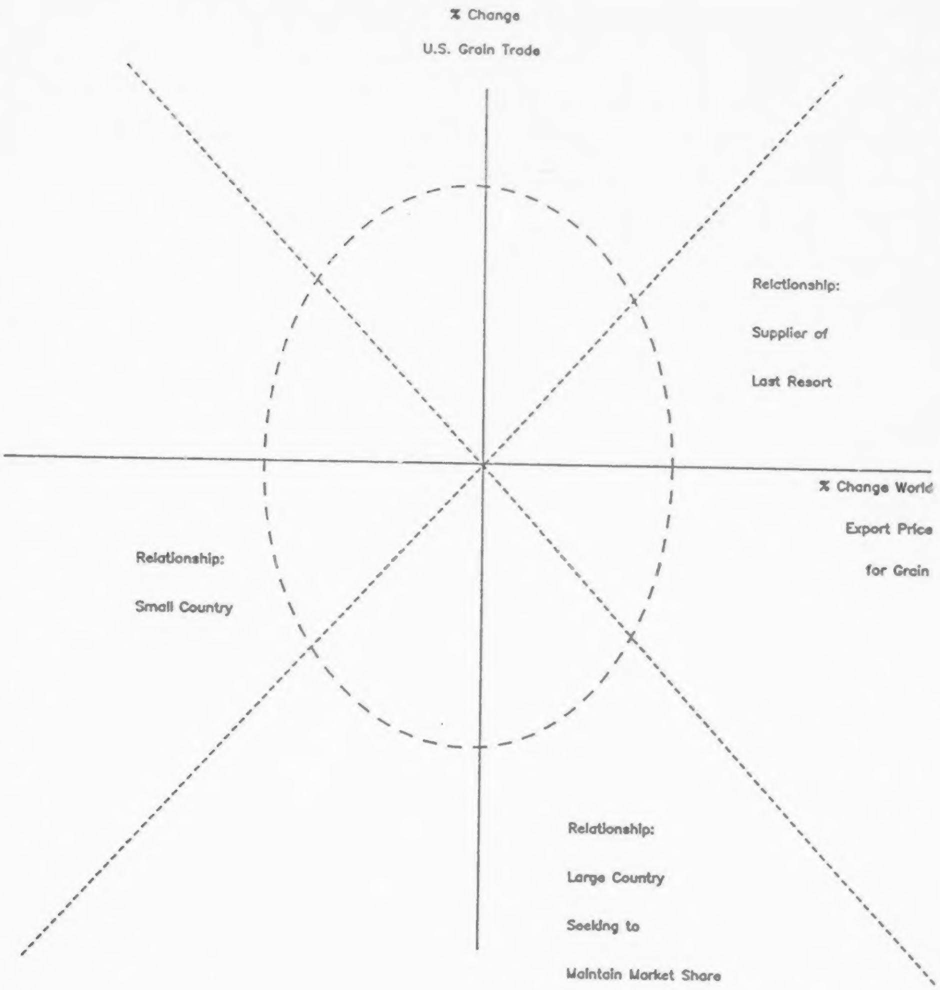
(1960–1984) (1.4) (8.2) $R^2 = 0.743$ D-W = 2.16

role of the United States in world grain markets. If, as many analysts have argued, the United States has become the de facto "supplier of last resort," the slope of the line that relates percentage changes in the volume of world grain trade to percentage changes in U.S. grain exports will be significantly greater than one. If the U.S. were a large but fully competitive country, the slope should be approximately one. If the United States were a small country in world grain trade, the slope should not be significantly different from zero. For the 25 years between 1960 and 1984 the coefficient was 1.86 and the *t*-statistic 8.2.

An additional issue concerns the strength of the relationship between the volume of U.S. agricultural exports and the value of those exports. If there were a fixed and known elasticity of demand for those exports, the sign could be determined unambiguously. But that elasticity is an *outcome* rather than a *cause* of the relationship. Again, three relationships are plausible, depending on the role of the United States in world grain markets and the size and competitiveness of those markets. As figure 5 illustrates, if the United States acts as a supplier of last resort, there should be a positive relationship between changes in the price it receives for grain exports and changes in the volume of those exports, which thus guarantees a positive overall relationship between export volume and export value.

If the United States is merely a regular competitor in world grain markets, there should be no significant relationship between its export volume and price received. If the United States acts as a large competitor in pursuit of market share in world grain markets, however, a significant *negative* relationship should exist between its export volume and price. This is the critical elasticity of demand for U.S. exports that is needed to determine whether export volume and value are positively related under this trade strategy, but it is precisely the elasticity that is unobservable from historic data if previous policy has not pursued this strategy. The statistical record for the same 25 years shows no significant relationship between percentage changes in either nominal or deflated world grain prices and percentage changes in U.S. grain exports, with or without a one-year lag, although the sign is always negative in the estimated functions.

Figure 5
Relationship Between Percentage Change in United States Grain Exports and Export Price of Grain


% Change
U.S. Grain Trade
Relationship:
Supplier of
Last Resort
% Change World
Export Price
for Grain
Relationship:
Small Country
Relationship:
Large Country
Seeking to
Maintain Market Share

Statistical Relationship:
% change in U.S. grain trade = 0.065 − 0.188 x % change in real price
(1960-1984) (1.7) (1.6) $R^2=0.063$ D-W=1.86
=0.065 − 0.041 x % change in lagged real price
(1.6) (0.3) $R^2=-0.045$ D-W=2.35

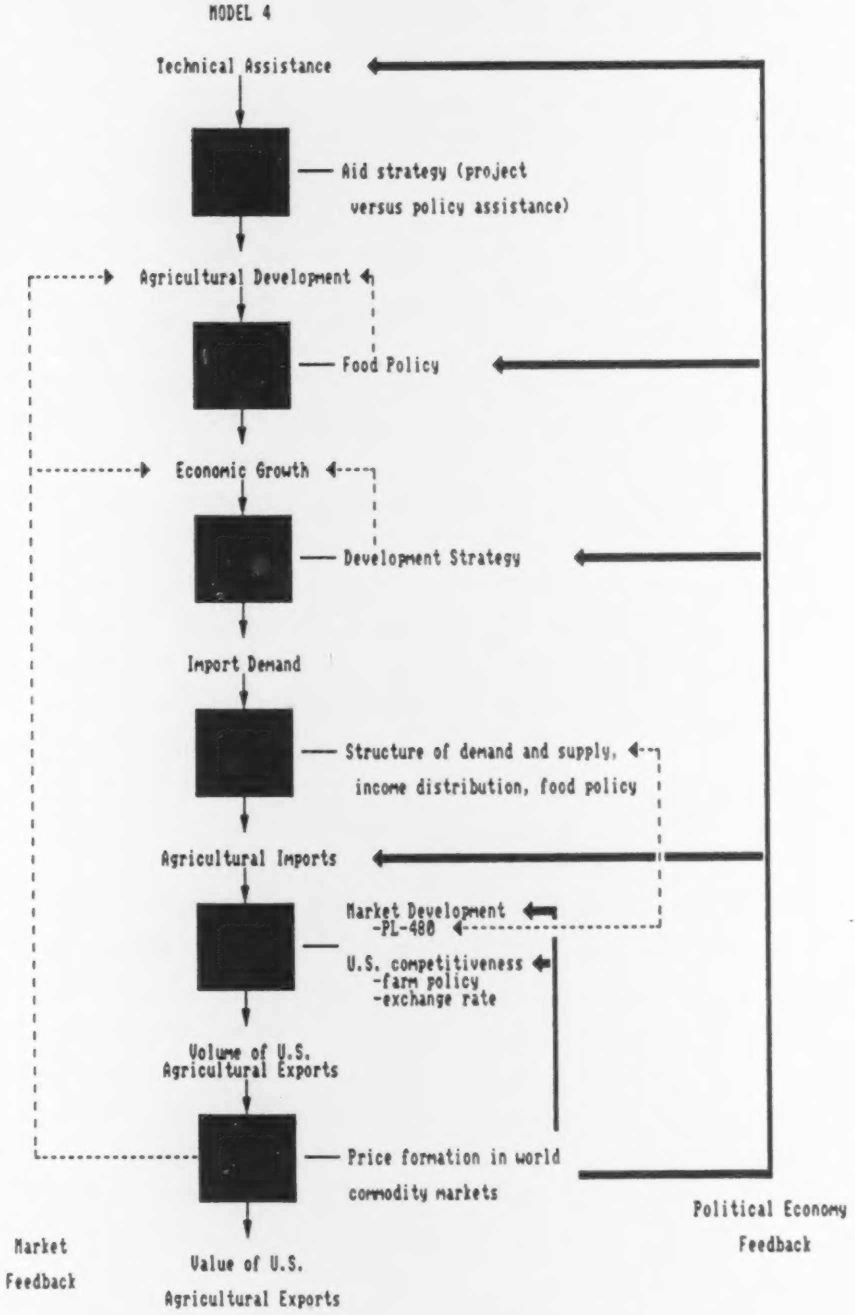
The question can now be put directly: what is known from Model 3 about the relationship between technical assistance and agricultural development in developing countries at the one end and the volume and value of U.S. agricultural exports at the other? The historical record suggests that each black box is likely to encompass a set of mechanisms that generate a net positive relationship between the input factor and the resulting output. If all the black boxes have positive signs, the overall relationship between agricultural development and U.S. agricultural exports should also be positive. This is exactly the result that Kellogg and his colleagues have found. So we have some confidence that Model 3 captures the short-run and partial equilibrium mechanisms connecting these two factors.

Two potentially important elements are missing in Model 3. First, the short-run links treated in Model 3 may be superimposed on more powerful, but lagged, connections that operate in the opposite direction. Some of these lagged relationships are economic but some work primarily through political choices made in the face of pressures emanating from the outcomes in Model 3. Second, price formation in world commodity markets cannot be treated in a partial equilibrium framework. The potential commodity substitutions and impact of financial variables such as debt and exchange rates have a powerful influence on these prices, which in turn enter the economic and political feedback mechanisms just noted. When these concerns are added to the linear format of Model 3, a much more complex set of relationships emerges, as is shown in Model 4 in figure 6.

The unidirectional causation of Model 3 gives way in Model 4 to several circular feedback mechanisms. Two have already been noted: the impact of inward- or outward-looking development strategies on the rate of economic growth and import demand; and the impact of food policy on agricultural development and its mediating role between that development and overall economic growth.[14]

The broader feedback mechanisms incorporate connections from both markets and political economy dynamics. On the left side of figure 6, signals from world commodity markets influence both agricultural development and economic growth, although with various lags. To the extent that market prices are communicated directly to farmers, the

Figure 6
Feedback Effects in the Relationship Between Technical Assistance and the Value of United States Agricultural Exports


MODEL 4
Technical Assistance
Aid strategy (project versus policy assistance)
Agricultural Development
Food Policy
Economic Growth
Development Strategy
Import Demand
Structure of demand and supply, income distribution, food policy
Agricultural Imports
Market Development
-PL-480
U.S. competitiveness
-farm policy
-exchange rate
Volume of U.S. Agricultural Exports
Price formation in world commodity markets
Market Feedback
Value of U.S. Agricultural Exports
Political Economy Feedback

crucial issue is the supply responsiveness of a nation's farmers to price incentives. This responsiveness is obviously a function of time and of public sector responsiveness as well. At the farm level, farmers might shift the area devoted to various commodities in the short run, or change fertilizer applications. In the longer run they can invest in water control, better production technology, and greater specialization if the market will take away their output and provide ample supplies of needed household consumption items in return.

The influence of world commodity markets on economic growth is through different mechanisms. By determining the amount of foreign exchange earned for a given volume of commodity exports, these markets directly influence how binding the foreign exchange constraint is. At the same time, the signals provide incentives to local entrepreneurs to supply export markets as opposed to domestic markets. Depressed world commodity markets tend to lead to depressed domestic markets through local price competition. Consequently, in those countries that permit relatively free transmission of world market prices into their domestic economies, a strong link exists between those markets and performance in agricultural development and overall economic growth. *If* one consequence of previous rapid agricultural development (and other factors influencing commodity prices) is to push down those prices on world commodity markets, then at least one market mechanism is established that will dampen further agricultural development and economic growth and thereby lead to a reduction in *demand* from developing countries for commodities from these markets.

The right side of figure 6 shows that there are important political economy mechanisms that establish this connection as well. Growing agricultural imports, especially at high prices, induce countries to devote more attention to their agricultural sectors to reduce their political exposure to unstable world markets. This wariness must be one of the major outcomes of the world food crisis in the mid-1970s. Some of the high prices of that period were felt directly by farmers as countries simply lost control of their domestic price stabilization programs. More important for the long run, however, was the signal to governments that it would be both expensive and politicially dangerous to rely on world markets for basic grains, a lesson that was reinforced by the soybean embargo and Soviet grain embargo attempted by the United States. The result was implementation of price policies with better incentives for farmers, more investment in rural infrastructure such as roads and irrigation, and far more serious attention to the development of an indigenous agricultural research and extension capacity (all of which are now the ingredients of "good" policy advice).

All of these changes take time to manifest themselves in terms of increased output, but when it arrives on domestic markets, a double-edged effect is felt on import demand from world commodity markets. Higher real prices in domestic markets induce both greater production and reduced demand. The result is sharply reduced import demand or even a switch to exports of important food and feed grains, as in the case of Indonesia, China, and India. If related factors such as falling petroleum prices and high debt levels are contributing to slowed economic growth in low- and middle-income countries, the added market supplies meet very sluggish growth in demand and thus exacerbate the downward price pressures on agricultural commodity markets. In a rather perverse twist, the falling petroleum prices and attempts to earn foreign exchange to meet debt repayment schedules reinforce these dynamics because agricultural exports have a shorter lead time and learning curve than industrial exports and face less protection in developed countries (until now). A rather vicious downward spiral is set in motion, which was initiated by an apparently healthy response to the world food crisis of the 1970s and the recycling of petrodollars.

How does the United States respond in such a situation? With surplus agricultural commodities on hand and a stark picture of hunger televised on the evening news, one temptation is to renew the market development thrust of the PL-480 program, to feed the hungry with America's bounty. But the potential dangers to agricultural development efforts of dumping our surpluses in substantial quantities into a country's domestic food markets are now well recognized.[15] Most countries would accept such food aid only if it directly offset commercial imports otherwise planned. Since this is contrary to both the letter and intent of the law, sharply expanded PL-480 shipments do not seem possible.

The commercial competitiveness of U.S. commodities is determined primarily by the value of the dollar in foreign currency markets and by domestic farm policy. Both of these factors are affected by prices in world markets and, in turn, have feedback effects on the outcome of each of the relationships shown in Model 4. Just as the devaluation of the dollar in the early 1970s for reasons unconnected to agriculture stimulated U.S. agricultural exports and farm earnings, so did its progressive revaluation during the early 1980s dampen those exports and earnings. The U.S. Congress does not legislate much positive agricultural trade policy; it does, however, set domestic agricultural price policy to protect farm incomes. The effect until the 1985 Farm Bill was to set the prices of many U.S. export commodities above those of the competition and thus lose market share, which resulted in higher prices for our competitors than would prevail with open competition.

The political economy dynamics of this approach are now becoming clear. Large budget deficits forced Congress to design a more competitive farm price policy even in the face of existing low incomes in the American farm sector (but large deficit costs remained because of continued target price support). Additional commodities will move onto world markets and drive prices down even further, at least temporarily. The lower prices make imports even more attractive to those countries open to international grain trade, but they simultaneously threaten further those countries that maintain active price policies on behalf of their farmers. Providing better price incentives to farmers in developing countries has become a main theme of policy advice that accompanies technical and financial assistance. A major contradiction is emerging between market signals and important elements in the agricultural development process. As American farmers watch more and more countries protect themselves from the pressures of low-priced U.S. agricultural commodities, the political pressures will increase on the land grant universities, USAID, and USDA to stop their assistance to agricultural development programs. Slowing the pace of agricultural development, however, will in fact slow the pace of economic growth in the developing countries. They will then serve as less dynamic markets for U.S. exports of all goods and services, including, in the short run, exports of agricultural commodities.

The Historical Record and Income-Led Growth

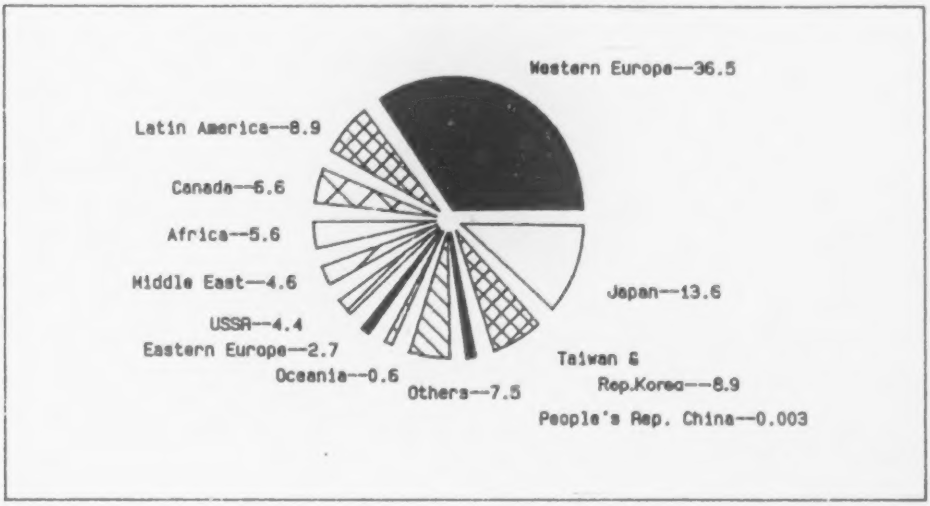
Despite the perilous and complicated feedback mechanisms that seem to be operating in Model 4, the long-run growth of agricultural imports in developing countries has been a stimulus to U.S. agricultural exports. Figure 7 shows the shares of U.S. agricultural exports to various destinations for fiscal year 1976-77 and projected for 1984-85. The share of developing countries, including China, rose from 35.5 percent in 1976-77 to 40.4 percent in 1984-85. The nominal value of total exports rose roughly 60 percent during that time while the consumer price index rose about 80 percent. After inflation, the real purchases of U.S. agricultural commodities by developing countries remained almost constant, helping to offset a decline in the real value of purchases from Western and Eastern Europe, Canada, and Oceania. Real purchases from Japan and the U.S.S.R. increased significantly.

Two quite separate forces seem to be at work in generating the increased demand for agricultural imports in developing countries. The first, and the smaller in absolute terms, is the failure of domestic agricultural production to keep pace with population growth and food demand in urban areas. This is primarily an African phenomenon. Table 1 shows that African imports of grain have increased from a total of 5.9 million metric tons in 1970 to an average of 24.9 million metric tons for the 1980-83 period, or by 13.3 percent per year. During the same period, production of corn, rice, and wheat increased 2.2 percent per year, substantially behind the 2.9 percent per year increase in population. Real per capita incomes have also been falling during this time, although certain regions and countries have shown significant increases.[16]

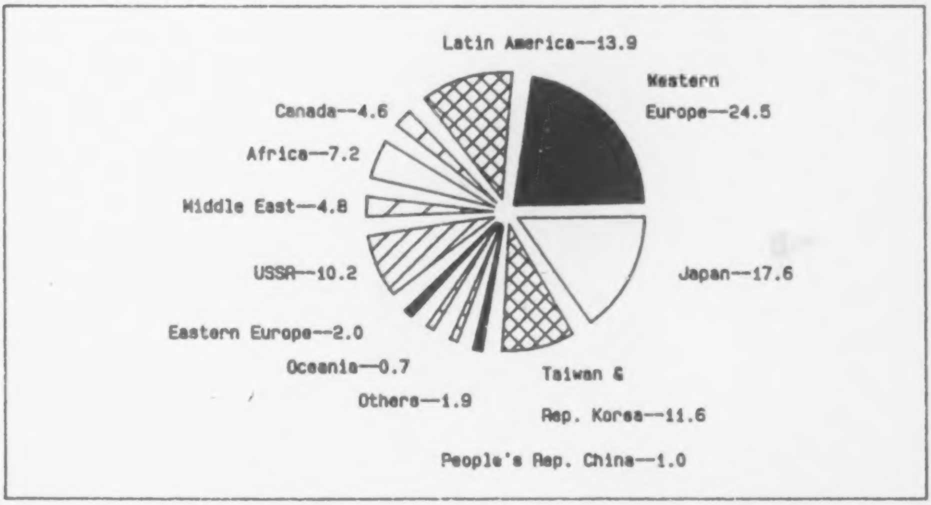
The great bulk of increased demand for U.S. agricultural exports over the past two decades has come from income-induced patterns of food consumption. This is most readily apparent from table 2, which is reproduced from Monke's paper on international grain trade for the World Bank.[17] Total growth in import demand for cereals between 1948-52 and 1979-81 was over 170 million metric tons, of which Monke attributes about 30 million metric tons to declines in per capita grain production and about 33.5 million metric tons to population growth.

Figure 7
U.S. Agricultural Export Percentage Shares to Selected Destinations
1976-77 and Projected 1984-85 Fiscal Years

Fiscal Year 1976-77



Fiscal Year 1984-85



SOURCE: U.S. Department of Agriculture, Economic Research Service, *Foreign Agricultural Trade of the United States* (Washington, D.C.), March-April 1985 and various other issues.

The remainder, 107 million metric tons, is a residual that must be accounted for by rising per capita incomes, changing tastes, urbanization, and so on.

Table 1
African Grain Imports by Region in Millions of Metric Tons
1970 and Yearly Average 1980-83

Grain/Region	1970	1980-83	Percent change 1970 to 1980-83
Corn			
N. Africa	.10	2.03	+1930
S. Africa	.20	.37	+85
Sub-Saharan Africa	.41	1.46	+256
Total	.71	3.87	+445
Rice			
N. Africa	.05	.25	+400
S. Africa	.08	.16	+100
Sub-Saharan Africa	.65	2.43	+274
Total	.78	2.84	+264
Wheat and Wheat Flour, Wheat Equivalent			
N. Africa	2.79	14.54	+421
S. Africa	.18	.14	-22
Sub-Saharan Africa	1.44	3.52	+144
Total	4.41	18.19	+312

SOURCE: Food and Agriculture Organization of the United Nations, *Trade Yearbook* (Rome, Italy), various issues.

Totals may not add up due to rounding.

The patterns of food demand generated by rising incomes have been studied for well over a century, and Engels Law—the declining share of food expenditures in total household expenditures as per capita incomes rise—has been well-documented from both time series and cross

Table 2
Sources of Growth in Import Demand for Cereals
1948/52 - 1979/81

Region	Total growth	Effects on import demand of: Declines in per capita production	Population growth	Residual
		(million metric tons)		
Developed				
Market economics	46.02	9.33	17.83	18.86
CPEs	46.30	0	1.74[a]	44.56
Developing				
Market economics	58.34	19.02	10.80	28.52
Africa	(11.50)	(9.66)	(1.11)	(0.73)
Latin America	(18.59)	(1.90)	(4.04)	(12.65)
Near East	(17.04)	(2.34)	(1.80)	(12.90)
Far East	(11.21)	(5.12)	(3.83)	(2.26)
CPEs	19.58	1.38	3.14[a]	15.06
Total	170.24	29.73	33.51	107.00

SOURCE: Eric A. Monke, "International Grain Trade, 1950-80," AGREP Division Working Paper (Washington, D.C.: The World Bank, January 1983).

a. Calculations for CPEs are made for the 1960-80 period, due to lack of data on intra-CPE trade for the 1948/52 period. Trade between market economics and CPEs was extremely small during this period, but increased substantially during the 1950s. If per capita imports by CPEs during the 1948/52 period were assumed equal to those of 1960, the effects of population growth on trade would increase to 2.77 and 4.15 million metric tons for the developed and developing CPEs, respectively. These calculations yield overestimates, and do not alter the conclusions presented in the text.

section data. The changing composition of the diet with rising incomes has also been scrutinized as agricultural ministries search for commodities with bright prospects for consumer demand in order to maximize the payoff to their research and extension efforts.[18]

Relatively less attention has been given to the indirect demand for commodities generated by the food consumption patterns of the more affluent. In 1974, Lester Brown presented a striking table showing the indirect demand for grain at income levels at which grain-fed livestock products became affordable. Grain demand per capita in the United States and Canada, for example, totaled five times the amount in India or China.[19] In times of grain shortages and pessimism over future supplies, this large indirect demand for grain was interpreted as a threat to the world's capacity to feed its poorer population. In times of surplus, indirect demand for grain is seen as an important source of export markets for U.S. farmers, and so it is worth examining the relationship between income and grain demand more closely.

The relationship depends heavily on the distinction between quantity and quality of the diet. Both of these attributes change as incomes increase, but the quality dimension is much more income-elastic after minimum caloric intake levels are reached. Tables 3 and 4 report the results of a systematic attempt to quantify these different trends; Appendix 1 shows the sources of data for the 34 countries in the sample and the composition of the 117 cases drawn from those countries. The income variable is measured in purchasing power parity as determined by Kravis and his colleagues. Prices are measured with similar adjustments to market or official exchange rates; consequently much of the real income effect of different price levels between poor and rich countries has already been captured in the income variable. Any significance of the variable measuring food prices relative to nonfood prices is thus capturing a pure substitution effect rather than an overall market effect, which includes both the real income effect of price changes as well as the substitution effect.

The first seven equations have log of caloric intake as the dependent variable. For the total sample, per capita income has a very high explanatory power, and the income elasticity is equal to 0.20 when income is entered alone in Equation C1. It remains as high as 0.15 in

Table 3
Elasticity Coefficients from Calorie Intake Regression Analysis Using Double Logarithmic Functions

(*t*-statistics in parentheses)

Equation			Per capita income	Food prices		Calorie requirement	Constant terms
Number	R²	Sample		Overall	Low income		
Calorie intake							
C1	0.75	Total	0.20 (18.77)				7.24
C2	0.76	Total	0.19 (16.04)	–0.10 (1.37)			
C3	0.77	Total	0.18 (13.77)		–0.20 (2.44)		7.32
C4	0.78	Total	0.15 (9.07)			0.81 (3.58)	1.08
C5	0.78	Total	0.15 (8.58)		–0.12 (1.46)	0.70 (2.96)	1.96
C6	0.04	DC	0.06 (1.30)	–0.05 (0.30)			7.84
C7	0.60	LDC	0.15 (8.67)	–0.10 (1.48)			7.38

Table 4
Elasticity Coefficients for Various Aspects of Diet Quality Using Double Logarithmic Regression Functions

(*t*-statistics in parentheses)

Equation			Per capita income		Constant terms		
Number	R^2	Sample	Overall	Low income	Overall	Low income	Miscellandous variables
Starchy staple ratio							
Q1	0.74	Total	–0.39		5.07		
			(18.25)				
Q2	0.75	Total	–0.35	0.03	4.92		
			(11.50)	(1.57)			
Q3	0.80	Total	–0.67	0.45	6.22	-1.56	
			(10.13)	(5.57)		(5.31)	
Q4	0.80	Total	–0.67	0.45	6.22	-1.60	0.245
			(10.19)	(5.58)		(5.46)	(1.50)
Q5	0.56	DC	–0.64		6.09		
			(8.25)				
Q6	0.41	LDC	–0.23		4.69		
			(6.39)				
Protein							
Q7	0.64	Total	0.25		3.46		
			(14.32)				
Q8	0.01	DC	0.04		4.36		
			(0.85)				
Q9	0.22	LDC	0.15		3.69		
			(4.11)				
Animal Protein							
Q10	0.81	Total	0.77		0.72		
			(22.39)				
Q11	0.41	DC	0.47		2.00		
			(6.19)				
Q12	0.52	LDC	0.65		0.97		
			(8.03)				

Equation C5 when variables are included for calorie requirements (which reflect average body size, activity levels, and climate) and for price response in low-income countries.

When the price variable is added in Equation C2, the income elasticity drops only slightly; the price elasticity is –0.1 and significant only at the 10 percent level. Prices and incomes are negatively correlated after the Kravis adjustments, and so the income variable captures some of the price effect. With prices alone in the equation, the estimated elasticity rises in absolute value from –0.10 to –0.66.

The elasticities for developing countries are expected to be larger than those for developed countries. The income elasticity should be higher because caloric intake has physical limits—"the narrow confines of the human stomach." The price elasticity estimated here, which is close to a pure substitution effect, should be higher because of the "Timmer effect," which states that "the pure substitution elasticity tends to decline in absolute size as incomes rise at about half the rate of decline in income elasticities. . . ."[20]

These issues are tested in Equations C6 and C7, which report separate equations for subsamples of the developed and less-developed nations. The income and price elasticities for developed countries are much lower than those for the developing countries and were not statistically significant. The Timmer effect was roughly confirmed. The decline in income elasticity from 0.15 for low-income countries to 0.06 for the high-income countries represents a decline of 60 percent. The decline in the substitution elasticity should therefore be about 30 percent. The actual decline is 50 percent, but a 30 percent decline is well within the likely margin or error.

The estimates of the "calorie requirement elasticity" in Equations C4 and C5 have little operational meaning other than the obvious: a 1 percent increase in "requirements" does *not* automatically lead to a 1 percent increase in caloric intake. Per capita incomes and food prices play a critical role in determining whether requirements can actually be satisfied.

Three measures of dietary quality are analyzed in table 4. Equation Q1 shows the starchy staple ratio regressed against income. The elasticity of –0.39 is highly significant and has substantial predictive power, as the simple equation has an R^2 of 0.74. Even the introduction of low-income slope and intercept shifters, along with a price term, raises the R^2 only to 0.80. Per capita incomes are clearly the dominant factor explaining this measure of dietary quality. To the extent a difference is likely to exist in income elasticities for the starchy staple ratio, the elasticity for developed countries should be larger in absolute terms. This would happen partly because the population of poor countries would exhibit a certain inertia in behavior—many wealthy individuals in Asia do not feel they have "eaten" without rice at a meal. In addition, significant scope exists for upgrading the diets of low-income populations within the context of starchy staples. Wheat can thus substitute for sorghum, or maize for cassava, and then rice for maize. Only when diets begin to diversify dramatically in quantitative terms to meat, sugar, fish, milk, and other high-quality and expensive calories does the starchy staple ratio decline rapidly.

This hypothesis is borne out in Equations Q5 and Q6. Separate equations for developed and developing countries show that the income elasticity of the starchy staple ratio is –0.64 and –0.23, respectively. Both coefficients are highly significant. A different formulation in Equation Q3 using dummy variables for low per capita incomes found virtually identical results.

The three equations for protein illustrate a characteristic of this particular sample and a behavioral relationship of some significance. Equation Q7 shows a protein-income elasticity of 0.25 when the total sample is combined. When the sample is split, the elasticity for developed countries is 0.04 and the low-income elasticity is 0.15. Neither elasticity from the split sample is as high as from the combined sample. Normally, the elasticity for the total sample should be a weighted average of the two subsamples. That is not true here for two reasons. First, the developed country sample represents a different population from that of the developing country sample due to different calorie requirements as well as to a host of other "modern" traits that do not come immediately with higher incomes. Second, patterns of behavior take considerable time to adjust to changed income levels. The elasticities for each sample separately can be thought of as representing short-run adjustments to income change, whereas the elasticity for the combined sample represents a long-run adjustment.

Equations Q10 to Q12 examine the relationship between animal protein and incomes. The income elasticity for animal protein is 0.77 for all countries but only 0.65 and 0.47 for developing and developed countries, respectively, which again shows the potential importance of short-run versus long-run dietary adaptations to income change. The implications of these large income elasticities for animal protein can be seen in table 5, which is patterned after Brown and reports both direct consumption of grain per capita and indirect consumption through livestock feeding, for a variety of countries from the United States to India.[21] Despite direct intake of grain in the United States of almost exactly one-half the Indian level, total grain consumed is 4.5 times as large as India's total grain consumption per capita—646 kilograms per years as opposed to 143 kilograms. The level was even higher before U.S. livestock feeders sharply reduced their feeding of grain in the wake of high grain prices in the mid-1970s.

A significant impact will be felt on world grain markets if "follower" countries adopt American-style diets and the indirect demand for grain implicit in them. If all the countries from Japan and below in table 5 were to reach the average level of grain consumed in the United Kingdom and Germany (340 kilograms per capita per year, a figure only slightly more than half the United States level), more than 300 million metric tons of additional grain would be needed, a figure equal to one-sixth of global production of grain. Excluding both India and China from the calculation leaves an added grain demand of more than 60 million metric tons, more than one-quarter of world grain trade in recent years.

If income growth procedes rapidly in these countries, the derived demand for grain through increased meat consumption will be a major factor determining the balance between supply and demand in world grain markets. Failure of incomes to grow as rapidly as in the past, however, will depress demand and could lead to significant grain surpluses in years of good harvests. If, in addition, there has been a structural change in the interaction of developing countries with world grain markets, as was argued previously, the outlook for American grain farmers is bleak indeed. This bleak outlook stems not from "surprises" in the black boxes, that is, in fundamentally different mechanisms connecting each level of a developing country's food system with the next. Rather, the changed outlook comes through the relatively greater importance of feedback mechanisms as income growth slows down. The more that income growth is stimulated through assistance to agricultural development, the more powerful will the feedback effects become. In addition, a set of largely external factors are impinging to make the prospects for U.S. grain exports in the 1980s less favorable than they were in the 1970s or even the 1960s.[22]

Table 5
Annual Per Capita Grain Consumption in Selected Countries
1975-1977 Average

	Grain consumed directly (kgs)	Grain consumed indirectly (kgs)	Total grain consumed (kgs)	Total grain consumed as multiple of India's consumption
USA	63	583	646	4.5
USSR	141	444	585	4.1
Argentina	100	275	375	2.6
Germany	67	288	355	2.5
U.K.	71	254	325	2.3
Japan	132	144	276	1.9
Korea	199	54	253	1.8
Brazil	91	124	215	1.5
China	156	52	208	1.5
Philippines	131	35	166	1.2
Indonesia	142	10	152	1.1
India	128	15	143	1.0

SOURCE: FAO, Food Balance Sheets, 1975-1977.

NOTE: Grain consumed indirectly is not corrected for imports and exports of meat and poultry.

The first of these factors is the unusual pattern of economic growth in the 1970s. The especially successful examples of agriculturally-led economic growth spilling over into rising agricultural imports have been in East Asia—Japan, South Korea, and Taiwan. All three countries have very low ratios of land to population, and all have relied heavily on industrial exports to the United States and Western Europe to fuel their growth, which has been extraordinarily rapid by either historic or contemporary comparative standards. While further gains in U.S. agricultural exports to these markets are possible, the largest increases have already been achieved. In addition, the United States faces sharp competition for these markets from other Asian countries whose export sectors have been stimulated by market-oriented food policies and the new structure of world commodity markets. Thailand, China, and Indonesia have the capacity to meet much of the rising demand for feedgrains in South Korea, Taiwan, and Japan. If Burma and Indo-China ever adopt market-oriented food policies that provide better farm incentives and public infrastructure for improved agricultural productivity, Asia could be awash in surplus grain.

The opportunities to reproduce the East Asian pattern of the 1960s and 1970s are practically nil. The lucrative markets of the OECD countries are increasingly closed to exports from newly industrializing countries. To earn the foreign exchange needed to import capital goods and to pay existing debt, most countries will be forced to export agricultural rather than industrial goods. The result will be added competition in world commodity markets, either directly as with rice, corn, soybeans, or cotton, or indirectly as with palm oil, rubber, or jute. As more countries seek sources of growth in agriculture, these competitive pressures will increase, and commodity prices will remain depressed.

Second, the technological basis for agricultural development in the 1980s and 1990s is likely to be significantly different from that in the 1970s. The Green Revolution of the 1970s was primarily based on wheat and rice systems with good water control. Much of the increase in U.S. agricultural exports in the 1970s was in coarse grains and soybeans, crops for which little new technology was applicable to the tropics. Because of significant progress in breeding and cultivation techniques, substantially higher yields for most of the coarse grains are now possible in the humid tropics, and similar progress may be in sight for legumes.[23]

A third factor depressing the outlook for U.S. agricultural exports is the erosion of its cost advantage in producing higher value-added products such as broilers, soymeal and oil, and textiles. When the basic commodities that provide the raw materials for these products cost more for domestic producers than they do for international competitors such as Thailand, Brazil, or China, it is impossible to retain markets previously established or to gain new ones. Between 1980-81 and 1983-84, the export of oilseed meals and poultry dropped by 34.4 percent, whereas overall U.S. agricultural exports fell by "only" 10.8 percent.

In total, three general sets of factors seem destined to make the 1980s a very different decade from the 1970s for American farmers: reduced global rates of growth in incomes; general equilibrium feedback effects on world commodity markets; and several specific features with respect to countries, technologies, and cost structures. There is only a limited response that U.S. policy can make in this new environment. Reducing the value of the dollar by bringing government expenditures in closer balance with revenues may raise the dollar price of commodities in world markets and help make American farmers more competitive, but it will make exports from developing countries less competitive and slow their rate of growth. The net effect on commodity markets is not clearly positive, and the dollar's decline since February 1985 has not helped very much by early 1987.

A more competitive pricing structure for U.S. farm products will help regain market share and also lower input costs for value-added products. But it will also drive down prices in world markets, at least in the short run, leaving basic commodity producers worse off.

United States technical assistance can focus on raising agricultural productivity in developing countries and rely on historical relationships to speed their economic growth and demand for agricultural imports. But if the lagged feedback mechanisms from both the market and political economy continue to push countries toward smaller food imports and increased emphasis on agricultural exports, the general equilibrium consequences of this strategy mean it will backfire as a vehicle for assisting American farmers.

One can only conclude that no solution exists to the problem of low incomes of American farmers if the policy intends for present farmers to produce more output at higher prices. A competition-oriented policy that drives down world prices may eventually force some high-cost competitors, especially smaller farms in Europe, out of the market, but it will lead to a significant shake-out of American producers as well. From the comfort of a university it is easy to say that this is inevitable, even good for farmers, because they will earn higher incomes in the industrial or service sector. Jobs in those sectors, however, depend on the general health of the United States economy, and this in turn depends on overall American competitiveness and capacity to sell abroad. And this returns the story to the very simple relationship in figure 1, in which economic growth in developing countries leads to increased import demand in general. Finding ways to help these countries speed their general development process is the critical task for the United States if it wants a healthy economy at home. The evidence and logic point to rapid agricultural development as the key to this process, even if it increases competitive pressures on American agriculture through a complicated web of feedback and general equilibrium processes. Policies that help farmers cope with these pressures by easing the pain of structural change are the only appropriate response.

NOTES

1. Earl Kellogg, "University Involvement in International Agricultural Development Activities: Important Issues for Public Education," paper given at the 1985 annual meeting of the Association of U.S. University Directors of International Agricultural Programs (AUSUDIAP), Athens, Georgia, May 31, 1985; processed, p. 19.

2. Kenneth L. Bachman and Leonardo A. Paulino, *Rapid Food Production Growth in Selected Developing Countries: A Comparative Analysis of Underlying Trends, 1961-76*, IFPRI Research Report no. 11 (Washington, D.C.: International Food Policy Research Institute, October 1979), p. 35.

3. Kellogg, *op. cit.*

4. John Lee and Matthew Shane, "United States Agricultural Interests and Growth in the Developing Economies: The Critical Linkage," paper presented at the National Planning Association Food and Agriculture Committee Meeting (USDA, Economic Research Service), Denver, May 1985.

5. Kellogg, *op. cit.*, p. 14.

6. The analysis is contained in a thesis being written by Richard Kodl at the University of Illinois.

7. Thomas K. Morrison, "An Analysis of Recent Trends and Determinants of Cereal Imports by Developing Countries" (Washington, D.C.: Research Department, International Monetary Fund, October 25, 1982), pp. 20-24,

8. Kellogg, *op. cit.*, p. 8.

9 See C. Peter Timmer, Walter P. Falcon, and Scott R. Pearson, *Food Policy Analysis* (Baltimore: Johns Hopkins University Press for the World Bank, 1983).

10. See Robert L. Paarlberg, "U.S. Agriculture and the Developing World: Partners or Competitors?" in Randall B. Purcell and Elizabeth Morrison, eds., *U.S. Agriculture and Third World Development: The Critical Linkage*, a policy study by the Curry Foundation, Lynne Rienner Publishers, Boulder and London, 1987.

11. This food policy also has feedback effects on the agricultural development effort itself, in analogous fashion to the feedback effects of development strategy on overall economic growth noted in Model 1. These effects are incorporated in Model 4.

12. Francis Moore Lappe and Joseph Collins, *Food First: Beyond the Myth of Scarcity*, rev. ed. (New York: Ballantine, 1979).

13. Julian Simon, *The Ultimate Resource* (Princeton: Princeton University Press, 1981); and Marilyn Chou and David P. Harmon, Jr., *Critical Food Issues of the Eighties*, Pergamon Policy Studies—39 (New York: Pergamon Press, 1979).

14. For the former, see Bela Belassa, "Outward Orientation"; in Hollis B. Chenery and T.N. Srinivasan, eds., *Handbook of Development Economics* (Amsterdam: North-Holland, Forthcoming); for the latter, Timmer, et al., *op. cit.*

15. See Raymond F. Hopkins, "The Evolution of Food Aid: Towards a Development First Regime," *Food Policy*, vol. 9, no. 4 (November 1984), pp. 345-62.

16. The World Food Institute, *World Food Trade and U.S. Agriculture, 1960-1984* (Ames, IA: Iowa State University, October 1985).

17. Eric A. Monke, "International Grain Trade, 1950-80," AGREP Division Working Paper (Washington, D.C.: The World Bank, January 1983).

18. See John W. Mellor, *The Economics of Agricultural Development* (Ithaca: Cornell University Press, 1966) for an early review of this topic, and Rajiv Chaudhri and C. Peter Timmer, "The Impact of Changing Affluence on Diets and Demand Patterns for Agricultural Commodities," AGREP Division Working Paper (Washington, D.C.: The World Bank, 1985) for a recent survey.

19. Lester R. Brown, with Erik P. Eckholm, *By Bread Alone* (New York: Praeger, 1974), p. 40.

20. C. Peter Timmer, "Is There 'Curvature' in the Slutsky Matrix?" *Review of Economics and Statistics*, 62, 3 (August 1981), pp. 395-402.

21 Brown, *op. cit.*, p. 40.

22. The following discussion has benefited from ongoing conversations with Wally Falcon about these topics.

23. For factors responsible for raising corn yields in Indonesia and the resulting impact on the domestic and export economies, see C. Peter Timmer, ed., *The Corn Economy of Indonesia* (Ithaca: Cornell University Press, 1987).

Appendix 1

Sources of Data

World Product and Income (1982) for real gross domestic income per capita for 34 countries for the years 1965, 1970, 1975, and 1977 as well as for purchasing power parities for 1975.

FAO, *Food Balance Sheets*, 1972-1974 and 1975-1977 for data on nutrient availability.

FAO, *Fourth World Food Survey*, 1977, for data on calorie requirements.

U.N., *Yearbook of National Accounts Statistics*, Volume II, 1979, for real GDP per capita growth rates.

ILO, *Yearbook of Labor Statistics*, 1979, for general and food price indices.

The 34 countries in the sample, with the number of observations for each, are as follows:

Developed countries

Austria (3)
Belgium (4)
Denmark (4)
France (4)
Hungary (2)
Ireland (4)
Italy (4)
Japan (4)
Luxembourg (4)
Netherlands (4)
Poland (1)
Romania (1)
Spain (4)
United Kingdom (4)
United States (4)
Yugoslavia (1)
Germany (4)

17 countries; 56 cases

Less-developed countries

Brazil (3)
Colombia (4)
India (3)
Iran (4)
Jamaica (3)
Kenya (4)
Korea (4)
Malawi (3)
Malaysia (4)
Mexico (4)
Pakistan (4)
Philippines (3)
Sri Lanka (4)
Syria (3)
Thailand (4)
Uruguay (4)
Zambia (3)

17 countries; 61 cases

TOTAL SAMPLE: 34 countries; 117 cases

Ending African Hunger

Six Challenges for Scientists, Policymakers and Politicians

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Nineteen-sixty is usually referred to as the beginning of Africa's independence movement because 16 African colonies won their independence in that year. Over the 1960 to 1985 period, however, at least 40 of the 45 countries in Sub-Saharan Africa wasted a generation in failing to develop their agriculture as an engine of growth of their national economies. After several decades of independence, Africa is still the poorest part of the world's economy and seven of every ten Africans live in rural areas. The dreams of African leaders of skipping stages of development and catching up with the rich countries in one or two generations have all but vanished, as despair, frustration and disappointment have become the code words in African political circles.

When African countries started to reclaim their independence in the 1960s, Sub-Saharan Africa was a modest net exporter of food—mostly groundnuts (peanuts) and palm oil to Europe. But Africa slowly lost its capacity to feed itself during the sixties. The situation deteriorated further in the seventies with the drought and famine in the Sahelian region of West Africa. During the 15-year period from 1970 to 1984, Africa's population grew at twice the rate of growth of food production. In 1985, 25 years after independence, 22 African states appealed to the international community for emergency food aid and 300,000 people died in the Great Ethiopian Famine.

In Africa's first 25 years of independence, only four or five of the forty-five countries in Sub-Saharan Africa gave priority to agriculture and to feeding their people. The remaining countries paid lip service

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The research supporting this chapter was financed by the U.S. Agency for International Development, Bureau for Science and Technology and Bureau for Africa, under a "Food Security in Africa" cooperative agreement with the Department of Agricultural Economics, Michigan State University.

to agriculture while emphasizing industrialization, state control and the taxation of agriculture. In this essay, I shall look back 25 years and examine why Africa wasted a generation in developing its agricultural base. I shall then look ahead and examine what can be done to end hunger in Africa over the next 25 years. I have taken the long view, i.e., the long pull—because there is little that can be done over the next five to ten years to slow population growth and end hunger in Africa.

Hunger can be defined as the inability of households to produce, purchase or acquire a calorie-adequate diet throughout the year. I shall focus on calories rather than protein because recent research has shown that, with the exception of pregnant women and nursing mothers, the protein needs of most people can be met if enough calories are consumed from multiple sources.

Although there are currently more hungry people in Asia than in Africa because of the sheer size of Asia's population relative to Africa, the most challenging and intractable problems of hunger and famine are in Sub-Saharan Africa: an immense land area of 45 countries, 7 colonial histories, and more than 1,000 different ethnic groups.[1] Moreover, most Asian countries have made enormous progress over the past few decades in controlling famine before it becomes a local or national disaster. For example, the last major famine in Asia occurred in Bangladesh in 1974 when 1.5 million people perished. In Africa, however, famine has not been brought under control. Famine in the Sahelian zone of West Africa in the early 1970s was followed by the Great African Famine in Ethiopia and Somalia of 1985.

Since Africa is an integral part of the international food equation, I shall examine the goal to end hunger in Africa in an international context, including the use of donor assistance and food aid in increasing food production and access to food. The hallmark of the world food equation of the late 1980s is underproduction of food in many African countries, overproduction in industrial nations such as the United States, Canada, Europe, Japan and Australia, and emerging overproduction of food in some Third World nations such as Brazil and India. For example, India recently joined the ranks of food aid donors when it delivered 100,000 tons of food aid to Africa in 1985. India plans to donate 35,000 tons of grain to Africa in 1987. Although India's achievement of food self-sufficiency and its generosity to Africa are to be admired, it should be pointed out that roughly 200 million or one-fourth of India's population are hungry and unable to acquire a calorie-adequate diet. The hungry in India are the landless, jobless, poor, and the destitute who are unable to produce, purchase or acquire enough calories to lead a normal life. Under these circumstances, why should India ship food aid to Africa except to gain political capital? Th lesson that emerges from India's experience for Africa is that the expansion of food production and the achievement of national food self-sufficiency will not automatically end hunger.

It is important to debate African hunger in the United States because there is a great deal of misinformation and facile slogans being peddled on the need for Africans to produce more food and fewer cash crops, the belief that hunger can be ended simply by increasing food production and the belief in some circles that hunger in Africa is caused by multinational firms and international capitalism.

I have chosen to discuss six challenges for ending hunger in Africa:

1. The challenge of learning why the first generation of African political leaders, policymakers, and their foreign advisors undervalued agriculture and food production over the 1960-84 period,
2. The challenge of slowing rapid population growth,
3. The human capital challenge,
4. The challenge of focusing on the prime movers of increasing food and agricultural production,
5. The challenge of reducing poverty and increasing access to food,
6. The challenge of reordering foreign aid priorities.

The Challenge of Learning from the Mistakes of the First Generation of African Leaders and Their Foreign Advisors: 1960 to 1985

Two essential questions must be addressed in an analysis of the poor performance of agriculture in the postindependence period. First, what role did African states assign to agriculture and the industrial sectors in national development strategies in the 1960s and 1970s? Second, what strategies were used by African states to increase food and agricultural production?

The postindependence experience provides a clear answer to the first question. Most western economic advisors to African governments in the 1960s promoted industrialization, rural to urban migration, and the taxation of agriculture. With the exception of a few countries such as the Ivory Coast, Cameroon, Rwanda, Kenya and Malawi, African political leaders undervalued agriculture and gave priority to industrial development at the same time the agriculture sector was usually heavily taxed to finance industrial projects and the urban symbols of modernization such as a soccer stadium, a new House of Parliament and a four-lane highway from the international airport to independence square in the capital city.

In the 1960s, most African heads of state did not believe in investing in the agricultural sector because of the view that industrialization offered the most rapid avenue to change the structure of African economies from traditional agrarian/export-dominated economies to modern industrial economies. But in practice, industrialization has proven to be more complex than imagined. Throughout Africa, industrial plants are now standing idle because of inefficiency, mismanagement, corruption and lack of markets. For example, while visiting Tanzania in October of 1985, I observed that the government-owned shoe factory in Morogoro that was financed by a World Bank loan was operating at 4.5 percent of capacity. I also observed that the cashew nut processing plants were standing idle because it was cheaper to ship raw cashew nuts to India for hand shelling because the unskilled wage in India was substantially lower than in Tanzania.

Why did most African heads of state impose such heavy taxes on agriculture for financing large-scale industrial projects? There is consistent evidence that African heads of state in anglophone and francophone states associated poverty and underdevelopment with colonial strategies of producing agricultural exports—sisal, cocoa, oil palm, rubber and coffee—for European markets. Whether the head of state was espousing capitalism or socialism, there was a view that continued investment in export crops for overseas markets would be risky and would continue Africa's dependence on western markets. This point of view is reflected in the late Walter Rodney's immensely popular book in African universities—*How Europe Underdeveloped Africa* (1974).

Houphet-Boigny—the President of the Ivory Coast and Hastings Banda, Life President of Malawi, are shining examples of veteran politicians who promoted agricultural development over the past 25 years. Blessed with a rich natural resource base, adequate rainfall and an open-door policy to immigrants from neighboring countries, today the Ivory Coast is a middle-income nation with a per capita income several times higher than that of Ghana even though Ghana was by far the richest country in West Africa at independence in 1958. Malawi, a landlocked country with a poor natural resource base, is not only self-sufficient in maize, the staple food, but it has exported maize for seven of the past ten years.

Over the past three to five years there has been a growing awareness among new African leaders such as Prime Minister Robert Mugabe of Zimbabwe, President Diouf of Senegal, and President Mwinyi of Tanzania, that an agriculture-led development strategy should be pursued in economies where 70 to 90 percent of the people live in rural areas and petroleum and minerals are not available to generate adequate foreign exchange. However, because of the diversity of Africa's natural resource base and opportunities for development, there is no single agricultural development model that can be advocated for Africa. The relative emphasis that a national development strategy gives to industry, mining and/or agriculture must be sorted out on a country-to-country basis. But we can conclude after 25 years of independence that most African states are starting to give greater priority to investment in agriculture and less to industry than they did five to ten years ago.

The second question—how to develop agriculture—was answered in most African states in the 1960s by narrow assumptions about African farmers and herders and a belief in the ease of importing agricultural technology and models of production (e.g., large-scale farms and ranches) from industrial countries. In Africa, in the 1960s—as in Asia and

Latin America in the 1950s—farmers and livestock owners were assumed to be irrational, inefficient and bound to a culture of tradition and poverty. It was also assumed by many African leaders and their foreign advisors that large-scale farms, plantations and ranches were more efficient than small farms. Throughout most of the 1960s and 1970s, African governments, donors and foreign advisors assumed that food crop technology was "on the shelf" or that it could be imported from temperate climates in Europe and North America. It was further assumed that the adoption of improved technology could be speeded up by increasing the number of extension agents to "educate" farmers on the need to spend less time on feasts, festivals and sorghum beer parties and more time on increasing food production. Many African governments followed this advice and from 1959 to 1980, the 45 countries in Africa hired an additional 50,000 extension agents under the mistaken assumption that extension agents, rather than technical packages,[2] were the missing link in developing African agriculture.

With few exceptions, the first generation of African leaders, whether they were the leaders of civilian, military, radical or conservative regimes—were consistent in giving priority to industrial/urban development, exploiting farmers and rural people by imposing harsh taxes on export crops and giving rural people little voice in setting national agriculture policies and development priorities. The first generation also failed to understand that agricultural development is a slow, evolutionary and complex process that does not lend itself to rhetoric, ideology or to crash food production campaigns. Since most countries wasted a generation in developing their agriculture, the challenge for the second generation of African leaders is to learn from the mistakes of the past in addressing the challenge of developing African agriculture and ending hunger. But the bottom line is that many older African leaders must be replaced with a new generation who realize that Africa's poverty and underdevelopment is, to a large extent, the result of misguided national development strategies that gave priority to industrialization rather than strengthening the agricultural base as a precondition for industrial development.

The Challenge of Slowing Rapid Population Growth

Africa's 3.2 percent annual rate of population growth is the highest in the world. In fact, the total population in the region is estimated to increase from 460 million in 1985 to 730 million in year 2000, an increase of almost 300 million in just 15 years. The total fertility rate—the average number of children born during a woman's lifetime—is 6.9 in Africa, the highest in the world.[3]

Looking ahead, most population experts are of the opinion that fertility rates will remain high for the next 10 to 20 years because of the following reasons:

1. *Erosion of the Custom of Abstinence.* In many countries, the custom of abstaining from sex after a child is born ranges from 40 days in some Islamic groups to two years for some ethnic groups in Central and West Africa. When abstinence exceeds a year, it is usually continued until the child is weaned from the breast. This can lead to a spacing as much as four years between children. But the custom of abstinence is eroding, thus raising fertility.
2. *From Breast to Bottle Feeding.* The biological process of breastfeeding suppresses ovulation up to two years for the most prolonged breast feeders. But the aggressive advertising of powdered milk and baby formula is leading to a shift from breast to bottle feeding, thus contributing to higher fertility rates.
3. *Slow Adoption of Contraceptives.* Knowledge about contraceptives is low in Africa. Two-thirds of women in Cameroon have never heard of them. Among the women in Kenya exposed to contraceptives, only 12 percent use them. Fewer than 5 percent of women exposed to contraceptives in Senegal—a Moslem country—use them (Bongaarts, Odele and Lesthaeghe 1984).

African attitudes toward rapid population growth are changing, however. In 1984, 40 African nations met in Kenya and adopted the Kilimanjaro Program of Action for Population that calls for family planning services to be made available to all couples—either free or at subsidized prices. Zimbabwe has recently become the first African nation to achieve a statistically verified reduction in fertility levels. More than 35 percent of urban women now use contraceptives in Zimbabwe.

Two demographic lessons emerge from the historical experience of the past 25 years. First, African heads of state, donor agencies and scientists have underestimated the acceleration of the annual rate of population growth from 2.6 percent in th early 1960s to an Africa average of 3.2 percent today. Second, political leaders and population experts have underestimated the valid economic reasons why rural families want more children and the length of time and resources that would be required to slow population growth rates. Under conditions of surplus land and the lack of a state social security service, children can make a positive economic contribution to their families by fetching firewood, cutting grass for animals, as well as providing support for their parents in their old age.

Western science currently has no proven technology to slow Africa's rapid population growth. For Americans obsessed with technological fixes, it is difficult to realize that flooding Africa with contraceptives is not the answer. The high fertility and population growth rates can only be slowed gradually through more improvements in health, women's schooling, and the reduction of poverty and infant mortality.

In summary, rapid population growth will exert pressure on the natural resource base throughout the continent. Africa's current 3.2 percent rate of population growth is roughly triple the rate of growth of population in presently industrial countries like Denmark and the Netherlands at a comparable stage in their economic history from 1850 to 1900, and in Japan from 1878 to 1912. Because of Africa's rapid rate of population growth, policies for increasing food production and slowing population growth must be conceptualized as long-term efforts because fertility rates are simply not going to plummet over the next five to ten years. The agonizing lesson that flows from the historical experience since 1960 is that slowing the population growth rate—like increasing food production—is a slow, evolutionary, stepwise process.

The Human Capital Challenge

When African nations started to reclaim their independence in the early 1960s, illiteracy rates exceeded 90 percent in many countries and drop-out rates were high. Moreover, the stock of university graduates was exceedingly low—around 100 in Zambia—at independence and the enrollment ratio of students enrolled in post-high school and universities was less than 1 percent. Moreover, Sub-Saharan African countries had one-fourth the number of skilled manpower per million people in 1970 that Asian countries had in 1960.

Looking back over the past 25 years, Africa has made enormous gains in education at all levels, especially up to around 1980. For example, the number of students enrolled in all levels—primary, secondary and post-secondary (includes technical schools and universities), increased fivefold over the 1970 to 1983 period. Despite these impressive achievements, however, there is growing evidence that 1980 was a turning point for education in Africa. Although total African expenditure on all levels of education grew from $3.8 billion in 1970 to $10.0 billion in 1980, total expenditure fell by 11 percent between 1980 and 1983. Moreover, the 8.4 percent annual rate of growth of primary schooling between 1970 and 1980 fell to 2.9 percent from 1980 to 1983. If the rate of primary school enrollment (2.9 percent) does not keep up with Africa's population growth of 3.2 percent, Africa's educational base will be eroded.

Africa's educational problems have been studied by a World Bank task force over the past two years. The core recommendation of the task force is to reduce the share of public investment on university-level education and to increase expenditures on primary and secondary education. This recommendation will be hotly criticized by leaders of African universities because they believe that shifting the relative mix of resources to primary and secondary schooling will make it difficult for Africa to develop its scientific capacity and reduce the number of expatriate teachers and researchers.

The development of higher education in Africa should be examined in historical perspective. When African nations became independent in the early 1960s, they were encouraged to import technology from industrial countries, to send Africans overseas for agricultural training and to rely on tens of thousands of teachers and technical advisors (technical assistance) to fill manpower gaps until students returned from overseas training. The desire for overseas training was reinforced by African leaders such as President Senghor of Senegal, a distinguished poet and leader of Senegal from independence in 1960 until he volunteered to retire in December 1980. Although Senghor personally encouraged Senegalese students to study business administration in the United States, one can legitimately pose the question: Why did President Senghor wait until 1979—19 years after independence—to start undergraduate training in agriculture in Senegal? This is a puzzle that merits closer examination because Senegal is a profoundly agrarian country with 70 percent of its people engaged in agriculture. The 19-year time gap cannot be blamed on French colonial policies. It is a reflection of the ambivalent attitude that Senghor and most first generation African leaders had for developing indigenous scientific capacity in food and agriculture.

After 25 years of independence, Africa is still heavily dependent on international advisors in most scientific and technical fields. For example, in the early 1980s, about $4 billion or half of the annual official foreign aid (public) to Africa was used to pay the salaries, and ''care and feeding'' of approximately 80,000 western experts (about 40,000 school teachers, and 40,000 expatriate advisors, managers, teachers and scientists). But the provision of Western (and to a lesser extent Eastern Bloc) technical assistance to Africa is coming under heavy attack because of its high cost ($100,000 to $150,000 per person per year), its rapid turnover, and its uneven quality. Overseas training is also under heavy attack because of the growing awareness among Africans that it is a stop gap measure for the inevitable decision that will have to be made to strengthen Africa's capacity to train its students at home. Sending foreign advisors to Africa and training Africans in the United States are politically popular to American taxpayers. Both activities contribute to the 75 percent of all American foreign aid that is currently returned to the United States in the form of tuition payments, salaries paid to American advisors, and income derived from the sale of U.S. products—fertilizer, wheat, rice and tractors—for African states. But there is a puzzle in the human capital equation that should be critically examined. Why did the U.S. government take the long view in India in the 1960s when it helped develop 23 new state agricultural universities and fund their development for the next 15 years? Why is the United States taking the short-run view in Africa in the 1980s?

Unfortunately little leadership is coming from Africa on educational reform. African universities are notoriously overstaffed, inefficient and expensive. For example, in 1980-81, Nigerian universities employed 52,000 staff (teachers, cooks, guards, servants) for a student population of 69,000. By contrast, 8,300 employees care for 67,000 students in the 16 public colleges and universities in the state of West Virginia in 1987 (*New York Times* 1987). Since virtually the total cost of a university education in Africa is paid for by the government, it is privately profitable for African families to send their children to universities. But the returns to society for university-level education are low under the present cost structure and priorities where students are trained in fields such as law, history, geography and political science instead of fields dominated by western advisors such as computer science, business administration, engineering and plant science.

Africa has inherited an elitist model of higher education from the British, French, German and Portuguese. Because of the bleak financial position of many African countries, higher education is now under stress and the quality of education is falling in many universities. A few countries are starting to introduce long overdue structural innovations, including the development of new university models that are relevant to the agrarian dominated continent. For example, Tanzania recently started a new agricultural university—Sokoine University of Agriculture—that is modeled after the Punjab state agricultural university in India, a university established in the 1960s with the assistance of U.S. foreign aid and technical support from Ohio State University. Ethiopia recently launched the Alemaya University of Agriculture at Alemaya.

The 25 major foreign aid donors in Africa, including the flagship donor—the World Bank—do not have a strategic plan on how to break the "iron grip" of fellowships for overseas training and providing technical experts to Africa. The time is ripe for a fundamental reexamination of human capital strategies in Africa. Most donors have retreated from investment in human capital. For example, Uma Lele of the World Bank reports that World Bank lending to education in Africa declined from 10.6 percent of African allocation in the 1960s, to 7.5 percent during the 1970s, and 4.1 percent over the 1980-84 period (Lele 1987, p. 326). In fact, in fiscal year 1984, the World Bank allocated only two educational loans to Africa totaling $25 million. The major western donors are standing on the sidelines supplying fellowships for overseas training and short-term technical assistance while studiously avoiding making the long-term commitment of funds and teachers for long-term human capital institution building projects that were routinely offered to Columbia, Brazil and Argentina in the 1950s and 1960s and to India and other Asian nations in the 1960s and 1970s.

In a continent with large amounts of idle land and energetic people, what strikes one most about Africa's underdevelopment is the disproportionate stock of skilled people between Africa and the rich countries and between Africa and Latin America and Asia. The challenge now is to assess the experience of the first 25 years of independence and to lay the groundwork for helping African nations develop new models of education that are more cost-effective, relevant and sustainable.

The Challenge of Focusing Policy Attention on the Prime Movers of Increasing Food and Agricultural Production

Because of favorable rainfall throughout most of Africa in 1985-87, the short-term food outlook for Africa is good. In fact, 12 African countries had grain surpluses in 1987. However, because of rapid population growth, Africa faces a major agricultural production challenge. Food supplies will have to be doubled every 17 to 25 years to keep up with rapid population growth. The agricultural sector of African nations will also have to generate jobs, new income streams for rural people and foreign exchange to enable national economies to import capital goods such as tractors, construction material, and mining equipment. However, African heads of state are being inundated with fragmented advice from Western donors and their advisors on how to increase and sustain annual food production growth rates of 3 to 5 percent over the next generation.

Over the past 25 years of working on African development problems, I have noted that planning for increasing food and agricultural production in Africa is heavily biased by the faddish and narrow views of the several dozen major donors, private voluntary agencies and legions of Western academic specialists who typically play up the role of a single factor of agricultural change such as new technology or pricing policy. Many of these academic specialists are zealously promoting the current fad of donors or their discipline. For example, many plant breeders are understandably preoccupied with a technological fix to Africa's food problems and in placing more emphasis on regenerative agriculture. Anthropologists are rightly concerned with the cultural barriers to expanded livestock offtake rates. Agricultural economists typically focus on one issue such as: credit, land reform or raising farm prices, while general economists are concerned with overvalued exchange rates and measures to speed market liberalization.

In a world of increasing specialization and a concern for quick fixes, there is an urgent need to move beyond single factors of agricultural development and focus on what I call the five prime movers of agricultural development as a policy package over the long pull.[4] These five prime movers of increasing food and agricultural production are:

1. New technology produced by public and private investments in agricultural research.
2. Human capital and managerial skills produced by investments in schools, training centers, and on-the-job experience.
3. Biological capital investments (e.g., improving livestock herds) and physical capital investment in infrastructure such as dams, irrigation, and roads.
4. Improvement in the performance of institutions such as marketing, credit and national agricultural research and extension services.
5. Favorable economic policy environment.

A significant characteristic of the first four prime movers is their long gestation period (10 to 25 years). For example, experience has shown that it takes ten years of research, on the average, to produce a new plant variety, and another five to eight years to gain widespread farmer adoption. It takes 10 to 15 years of research on the average to develop new technology for increasing livestock production. It takes 10 to 15 years of graduate study and on-the-job training for an agricultural research scientist to be productive. Unfortunately this time span is not being reflected in African development plans or in Western foreign aid programs that too often move from one short-term fad to another.

The second characteristic of the prime movers of agricultural development is their complementary nature and the need to develop an integrated investment plan for research, extension, training, etc. The payoff to investment to produce new food, cash crop and livestock and technology will be low unless there is an effective extension service to diffuse the new technology. Likewise, the payoff to investing in agricultural extension services in Africa has generally been low because many national agricultural research services have had little to offer to extension agents. For example, the decision of African states to hire 50,000 additional extension agents over the 1959 to 1980 period was a mistake in my judgment because there was little proven food crop technology available for the extension agents to extend with a few exceptions, such as corn in eastern and southern Africa. For example, although the French started research on millet—a crop that does well in low rainfall (300 to 450 mm)—in Senegal in 1931, there is still no breakthrough in millet research in Africa after five decades of research.

Let us now examine what can be done to step up food and agricultural production in Africa by concentrating on the five prime movers.

Technology Generation. There is growing support for the proposition that expanded rural income from multiple sources is a strategic variable in addressing the hunger and poverty in Africa. In short, combating hunger is a more complex process than merely increasing food production. Hunger can be combated by expanding the production and sale of food crops, export crops, livestock, food and income earned from rural off farm employment. Agricultural research that generates new production technology for food crops, export crops, and livestock, can be important sources of income generation for farmers and a means for families to produce food or the income to purchase an improved diet. There is lack of agreement in the scientific community on the extent of the backlog of improved food crop varieties that are "on the shelf" waiting for extension agents to diffuse them to farmers. For example, Dunstan Spencer, an authority on African agriculture from Sierra Leone recently reported that probably less than 2 percent of total sorghum, millet and upland rice area in West Africa is sown with cultivars (varieties) through modern genetic research (Spencer 1986, p. 224). On the other hand, the Food and Agriculture Organization (FAO), of the United Nations, recently asserted that in Africa "except in arid and semi-arid areas without irrigation, food production can be roughly doubled with existing technology. Thus, the immediate need is to provide adequate supplies of fertilizer, improved seeds, tools. . . ."(FAO 1986, p. 61).

I am of the opinion that the FAO and many other agencies have overstated the amount of underutilized technology that is on the shelf waiting for farmers to adopt. The stock of on-shelf improved, farmer-tested food crop technology is limited today in Africa. The few notable exceptions include corn in eastern and southern Africa, hybrid sorghum in the Sudan, potatoes in Rwanda, cassava in West Africa, and wheat for the cool highlands of Ethiopia, Kenya, northern Tanzania and in Zimbabwe where it can be grown in the cool winter months (May-September) under irrigation. There is a growing realization that many of the national research services in Africa do not have the scientific capacity to borrow, screen, test and adapt agricultural technology from neighboring countries, regional institutes, the International Agricultural Research Centers (IARCs) and the global research system.

The strategic importance of an efficient national agricultural research capacity to develop new crop and livestock technology is illustrated by Zimbabwe's overflowing grain silos. Currently, Zimbabwe has corn in storage equivalent to two years of normal domestic consumption. Corn contributes about 50 percent of the calories in the average diet in Zimbabwe and it is the staple food in diets in most eastern and southern Africa. Zimbabwe's corn revolution is of special interest to African countries because the production of corn by small farmers (smallholders) tripled from independence in 1980 to 1986. The highlights of Zimbabwe's corn revolution are as follows:

- Zimbabwe's corn revolution has its origins in research on hybrid varieties that was launched in Zimbabwe (formerly Southern

Rhodesia) in the 1930s. Zimbabwe became the first country after the U.S. to introduce hybrid corn in 1950 after carrying out local research from 1932 to 1950. Subsequent research in the 1950s led to the development of a high yielding hybrid variety (SR-52) that was released in 1960 to commercial (large scale) farmers. The 28 years of local research (1932 to 1960) to develop the famous SR-52 hybrid corn variety (the Green Revolution crop of Southern Africa) makes a mockery of the three to five year agricultural research projects that are being currently peddled by foreign donors (Eicher 1984).

- Research from 1960 to 1975 developed shorter season varieties for small farmers in low rainfall areas. At independence in 1980, Zimbabwe had a backlog of corn varieties ready for delivery to small farmers. Today, 100 percent of the commercial farmers and roughly 85 percent of the small farmers use hybrid corn varieties, the highest of any African country (Rohrbach 1987).
- Public investments in roads, credit, extension and supporting services facilitated the expansion of hybrid maize production by smallholders from 1980 to 1986.
- Corn prices to farmers were raised from 1980 to 1986 but the inflation-adjusted prices have fallen since 1984. Hence, maize pricing policy by itself does not shed much light on Zimbabwe's maize revolution.

The message that emerges from Zimbabwe's corn revolution is that no single prime mover such as favorable corn prices was responsible for tripling of production by smallholders over the past six years. Zimbabwe concentrated on the five prime movers as a policy package over a period of decades and developed the preconditions for the "takeoff" in maize production starting at independence in 1980. This is the central finding that emerges from Zimbabwe's corn revolution—a message that is important for other African states, the U.S. Congress and foreign aid donors.

Human Capital and Managerial Skills. I have already commented on the great uncertainty on how to strengthen human capital in Africa. A major challenge facing educators and professional agriculturalists in

African and donor agencies is figuring out how foreign assistance can most effectively assist in strengthening Africa's indigenous scientific, technical and managerial capacity in food and agriculture. Starting with great confidence in the 1960s, the major donors and the U.S. foundations have retreated from investment in human capital in the 1970s and 1980s. For example, the World Bank only extended two educational loans to Africa in 1984.

Rural Capital Formation. Agricultural development in industrial countries has been fueled by the mobilization of family labor for clearing land, picking stones and building fences, an accretionary type of capital formation whereby family labor improves land productivity and the productivity of livestock herds over generations. Security of tenure plays a strategic role in converting family labor into capital formation because, with security, farmers can be assured that farm improvements can be passed on to the next generation. Unfortunately, in Africa there is a tendency for donors and private voluntary agencies to dole out subsidized credit instead of pressuring African governments to raise interest rates in post office savings banks, rural credit banks, etc., in order that farmers will have some incentive to save and finance their own farm improvements. There is a need for African planning to develop policies and institutions for African farm families to finance their own farm investments as the primary source of rural capital formation.

Rural Institutions. The fourth prime mover is strengthening the performance of rural institutions ranging from farmer irrigation associations to fertilizer, credit and seed companies. But there is a paucity of proven strategies on how to strengthen rural institutions such as national agricultural research, credit and extension services. Gunnar Myrdal, the Nobel Laureate in Economics from Sweden, recently observed that unfortunately most "ordinary" economists assume away institutions in their studies of Third World development (Myrdal 1984).

Favorable Economic Policy Environment. The fifth prime mover—favorable economic policy environment—is crucially important in facilitating the implementation of the first four prime movers. Currently in Africa, the major donors—led by the IMF and the World Bank—are pressing African states for policy reforms in exchange for additional loans and grants. But there are few solid guidelines on the difficult art of restructuring institutions such as phasing out or abolishing government grain boards, abolishing fertilizer subsidies and increasing the role of private traders in delivering farm inputs and in marketing farm products. In Zambia, President Kaunda's regime came close to being toppled in November of 1986 when 15 people were killed in food riots following the government's decision to double the retail price of cornmeal—the staple food of the country—on the advice of the IMF and several influential western donors.

In summary, there is a need for African governments and donors to focus on the five prime movers of agricultural development as a policy package to strengthen the productive capacity of African agriculture over the long pull. Food aid can be used to buy time until investment in these prime movers pays off. But donors need to come to grips with long gestation investments by making an explicit, up-front commitment to financing human capital and institution building projects for 10 to 20 years in Africa, just as they did in Asia in the 1960s and 1970s.

The Challenge of Reducing Poverty and Increasing Access to Food

A comparative study of the causes of hunger in the United States, India and Zimbabwe would reveal that hunger is not simply caused by the insufficiency of national food production, but poverty, unemployment, landlessness, sickness and other factors. We have questioned India's motives in sending food aid to Africa when about one-fourth (200 million) of its population is hungry. Since each of these three countries has achieved national food self-sufficiency, one has to look beyond lagging food production as the cause of hunger and food insecurity. Since poverty is a major cause of hunger in both rich and poor countries, raising per capita incomes is a powerful instrument for helping reduce hunger in the long run. But the long run may take 20 to 30 years or longer to raise per capita incomes sufficiently to enable people to purchase an adequate diet. Therefore, the central policy question is: Do governments have an obligation to intervene in the short run to reduce hunger in rich and poor countries, including both food deficit and food surplus countries?

In the United States it took several decades of political debate before a consensus was reached on the need for the federal government to finance food stamps to enable the poor, sick, and the unemployed to acquire a calorie-adequate diet. Over the past 15 years under both Republican and Democratic administrations, the United States has invested $9 to 20 billion per year in food transfer programs. But food stamps and other public food transfer programs require careful economic analysis in the Third World. This is especially the case in Africa where the annual per capita income of one-fourth the countries is below $400[5] and the national economies are strapped to maintain—let alone increase—public expenditures on health, education and other basic services. For example, in Senegal the per capita income is lower today than it was at independence in 1960. In Zambia the average per capita income is now almost one-third lower than it was when President Kaunda took over from the British at independence (*Economist* 1987).

In 1987, one-fourth of the African countries (12) had food surpluses and three-fourths (33) had food deficits. The challenge in food deficit countries is to help increase food production especially among subsistence farmers. Increasing food production under conditions of rapid population growth requires attention to the prime movers of agricultural development over the long pull.

In 1987, 12 African countries had achieved national food self-sufficiency and had grain for sale to neighboring countries. But in most of these countries, malnutrition is still a major problem because the poor lack the means (e.g., jobs, income, and credit) to produce and/or purchase a calorie-adequate diet. There is growing awareness in African policy circles and among donors that expanded food production and the achievement of national food self-sufficiency will not automatically end hunger and that poverty must be addressed in a policy package to increase food intake among the malnourished.

Fortunately the rhetoric of national food self-sufficiency in many African countries is diminishing and more countries are starting to focus on both sides of the food security equation—food availability—and increasing access to food by rural and urban households. Today there is growing awareness of the need for income and employment generating activities (e.g., cash crop production such as cotton and rural small scale industries) to help families acquire the means to increase their access to food.

The Challenge of Reordering Foreign Aid Priorities

Following the Sahelian drought in the mid-seventies, foreign aid to Africa was increased dramatically. For example, foreign aid to the Sahelian countries of West Africa increased at a 40 percent compound annual rate of growth over the 1971-78 period (Berg 1983, p. 45). Today most African countries are receiving two to three times more foreign aid on a per capita basis than their counterparts in Asia. Hence, one cannot make a blanket case for increasing foreign aid to Africa. In fact, in some African countries such as Tanzania, Sudan, Liberia, Senegal and Zaire, foreign aid has been a mixed blessing because of misguided macroeconomic policies, and low political priority to agriculture. In almost all African countries, aid is being delivered by a myriad of donor agencies in the form of short-term projects that do little to strengthen Africa's basic institutions such as schools, universities and national agricultural research services. Careful research would probably reveal that Africa has received too much official development assistance—especially since 1975—in the form of discrete short-term projects. In general, foreign aid has not lived up to its full potential in Africa because most donors shift from fad to fad (e.g., integrated rural development to basic needs to policy reform) and from subregion to subregion (e.g., Sahel to southern Africa).

Since the mid-1980s, most donors have shifted from project to policy-based lending under the belief that many of the tens of thousands of development projects across Africa (e.g., Kenya had around 1,000 development projects in all sectors in 1985) are not performing well because of adverse macroeconomic policies, excessive state control and subsidies. But there is a basic inconsistency in IMF and World Bank appeals to African countries to reduce the level of subsidies in light of the heavy role that subsidies play in contributing to food surpluses in rich countries such as the United States, Japan and in Western Europe.

Since there are many recent book length treatments of foreign aid (Cassen and Associates 1986) the best one can do here in the limited space is to point up the complexity of aid and the difficulty of generalizing about the efficiency of aid across 45 countries in Africa. The most important lesson that donors should learn from the postindependence foreign aid experience is that Africa is an agrarian continent today as it was at independence in 1960. Donors should put their assistance behind the five prime movers of agricultural development over the long pull.

Summing Up

Cutting across the 45 countries in Sub-Saharan Africa is the extraordinary diversity of African people, their cultures, natural resource endowments, stage of development and opportunities for development. The more experience one gains in Africa, the more one avoids the facile Pan African generalizations such as Africa is a land surplus continent. From the past 25 years of Africa's struggle to develop nation-states, to forge national identities and to improve the welfare of African people, the following generalization flow about food and agriculture.

There is a need to grasp the immensity and diversity of the African continent and to seek insights into development problems and solutions on a subregional basis such as southern Africa, East Africa, Sahel, Central Africa, etc. For example, because of a backlog of proven varieties of its staple food—corn—the food outlook in southern Africa is reasonably optimistic over the coming five to ten years. On the other hand, in semi-arid regions such as the Sahel, the food outlook is pessimistic because of the lack of a proven technical package for the two staple foods consumed by rural people—sorghum and millet—and the lack of proven technology for the two urban crops, rice and wheat.

Rapid population growth will not slow down in the medium term of six to ten years. Flooding Africa with contraceptives will not bring about a quick reduction in fertility rates. Rapid population growth of 3 to 4 percent per year requires food supplies to grow at 3 to 5 percent per year—an extraordinary difficult task judging from historical experience. Despite favorable weather in most of Africa in 1985 and 1986, Africa faces an enormous food production challenge until population growth rates slow down over the next 10 to 20 years.

There is a need for stepping up investment in scientific training in Africa, in reducing the number of fellowships for overseas training, and for strengthening Africa's research and teaching institutions over a time span of the next three to four decades.

Expanding food production in and of itself cannot end hunger in Africa. Since hunger exists in food surplus nations such as India and the United States, it follows that vigorous income and employment generation programs are critical in helping people increase their access to food. Presently there is little debate on food access in Africa because of the legacy of the drought, the preoccupation of Ministries of Agriculture in increasing production and the prevailing view that a food production shortfall rather than poverty is the main cause of hunger. A vigorous educational program should be launched to move policy debate beyond food self-sufficiency to include both sides of the food security equation—food availability through domestic production, storage and trade and access to food through home production, employment, purchase in the market and food transfers such as food aid.

NOTES

1. Africa will be used in the balance of this chapter to mean Sub-Saharan Africa.

2. A technical package contains two or more components (e.g., new seed, fertilizer) that a farmer/herder can adopt to increase crop or livestock production.

3. The total fertility rate in many industrial countries is 1.8 to 2.2.

4. See Eicher (1985) for an expanded discussion of the five prime movers.

5. The World Bank defines a poor country as one with an average per capita income of less than $400.